

the review of
POPULAR



ASTRONOMY

FORMERLY . . . THE
Monthly Evening Sky Map

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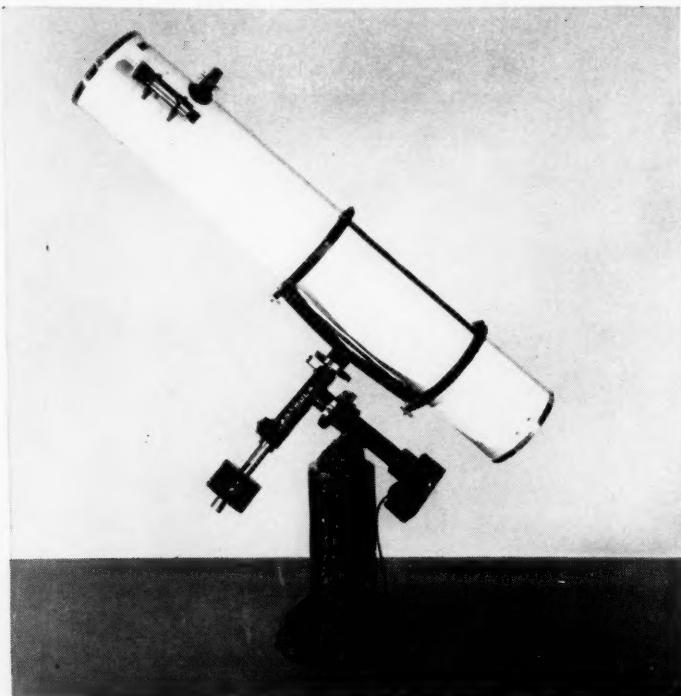
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JANUARY
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FORMERLY THE
MONTHLY EVENING SKY MAP

the
review of
**POPULAR
ASTRONOMY**

JANUARY-FEBRUARY 1961
VOL. LV WHOLE NUMBER 509

**THE REVIEW OF
POPULAR ASTRONOMY**

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C O V E R P H O T O

The cover photo for this issue is one of the finest examples of amateur astronomical photography the editors have seen. At top (north) are Zeta, Epsilon and Delta Orionis, the "Belt Stars" in Orion. Enveloped in nebulosity is Zeta, and just below is the striking mass of obscuring matter called "the Horsehead Nebula." South of the belt is the Great Nebula which surrounds Theta Orionis. Photograph was made by Alan McClure of Los Angeles, using a Goto lens of 20" focal length and an aperture of 3½ inches (f/6.3). Exposure was on Eastman 103aE plate, guided for 1h 45m. (See book review, *Outer Space Photography*, page 22.)

THE REVIEW OF POPULAR ASTRONOMY is published bimonthly by Sky Map Publications, Inc., P.O. Box 231, St. Louis, Mo. The magazine is a continuation and expansion of **THE MONTHLY EVENING SKY MAP**, which was founded in 1905 by Leon Barritt. It is a review of astronomy at the popular level. Subscription rates are \$3.00 for one year and \$5.00 for two years. For subscriptions outside of the U. S., its territories and possessions, Canada and Mexico, \$1.00 should be added for each year of subscription to cover mailing costs.

Articles, letters, photographs and other communications are encouraged and will be given the attention of the editors, although we cannot be responsible for their return in the case of unsolicited articles. All articles, photos, charts and other editorial matter in the magazine are protected by copyright, and permission must be obtained from the publisher for their use in other publications.

"THE REVIEW OF POPULAR ASTRONOMY"

For more than half a century the venerable **MONTHLY EVENING SKY MAP** of Leon Barritt and Garrett Serviss has been very much a part of the astronomical scene. Having its start early in the century as a syndicated newspaper series, then growing slowly into a small circular and finally to a 16-page journal, the **SKY MAP** had its happy band of followers, and quite possibly brought more people to a love for the stars than any other publication of its era.

But, the horizons of popular astronomy have expanded, and the **SKY MAP** had bulged a bit at its covers during the past year in an effort to keep up. Now—in the seventh decade of this century—astronomy and its domain have captured the minds and imaginations of the millions, and there is an ever-increasing need for the responsible dissemination of information on astronomy at the popular level. It is this which has led us to expand considerably the scope of this magazine and to offer its pages as an additional forum for the amateur of astronomy. In doing so, we have become increasingly aware of the misleading and limiting nature of the name "Monthly Evening Sky Map." Thus, it has been a natural development, in looking for a new title that reflects the purpose of this magazine, that we come to the name of "The Review of Popular Astronomy."

To some of our readers whose interest in astronomy dates back a decade or more, the name of "Popular Astronomy" is a familiar one—as it most certainly is to the editors of this magazine. For more than half a century, the journal **POPULAR ASTRONOMY** was published at the Goodsell Observatory of Carleton College in Northfield, Minn., until December, 1951.

At that time Carleton College found that it could no longer continue to publish the journal. Attempts were made to continue it under other auspices, and it was a great disappointment to its many readers when it was finally announced that publication had been discontinued and that the name would disappear from the future literature of astronomy. Its list of contributors had been a veritable "who's who" of astronomy, and the successive editorships of founder William W. Payne, Herbert C. Wilson, and finally, Curvin C. Gingrich—all of the Carleton College faculty—carried the magazine to a position of esteem in the amateur and professional astronomical world.

Thus, in bringing the name of "The Review of Popular Astronomy" to the cover of our publication, it would be presumptuous if we were to suggest that the magazine is in any way connected with Carleton College or that it is a continuation of the old **POPULAR ASTRONOMY**.

Instead, **THE REVIEW OF POPULAR ASTRONOMY** will be a continuation of the **MONTHLY EVENING SKY MAP** as presently conceived and will incorporate this name in its subtitle—" . . . formerly the Monthly Evening Sky Map." The new title also serves to give the magazine individuality and to allow it to be abbreviated clearly in references and bibliographies (R. P. A. or Rev. of Pop. Ast., e.g.).

Few of our potential readers will have been familiar with the old **POPULAR ASTRONOMY**, but we're certain that those who are familiar with it will be happy to find the name once more in the service of astronomy.

DONALD D. ZAHNER,
Editor-Publisher
ARMAND N. SPITZ
Associate Editor

ASTRONOMY AT THE SUMMIT

. . . the story of Pic-du-Midi

THOMAS W. RACKHAM

University of Manchester. England

To those of us who live in the flatter and more populated regions of the earth the prospect of being carried up a high and steep mountain, along narrow snow-glazed roads overhanging almost vertical precipices, holds but scant appeal. And others may exhibit some reluctance, not to say temerity, at the idea of ascending the same mountain in a swaying cable-car that hangs pendulously over thousand-foot gulf from a cable that is little more than one inch in diameter. However, unless the visitor is prepared to climb the mountain on foot—a far more hazardous occupation—one of these modes of transport must be chosen if

he wishes to visit the Pic-du-Midi Observatory in the French Pyrenees. Even this choice is available to him for only about two months of the year only—the rest of the time the mountain and the observatory on its summit wear thick mantles of snow, and the serpentine mountain roads are impassable.

The Pic-du-Midi de Bigorre, to give it its full name, is about 100 miles each of Biarritz, and approximately 20 miles away from the pilgrim city of Lourdes, which is the site of the famous Grotto of Bernadette. The main offices and workshops of the "Pic" are to be found in Bagnères-de-Bigorre, which is a small and

quaint market town, famous for the beneficial properties of the mineral waters that bubble out from the thermal springs, and which were known to the Romans 2,000 years ago.

In winter the Pyrenees are under deep snow—in fact, the whole region has been justifiably compared to parts of the Antarctic continent both for temperature and snowfall—yet the actual notion of building a scientific establishment on this 9,400-foot mountain goes back in time to before the French Revolution of 1789. Much later, in 1855, Le Verrier, who at that time was organizing the French Meteorological Service, suggested that a meteorological observatory should be built on the mountain. Despite this, little would have been accomplished had it not been for the efforts of Dr. Costallet of Bagnères-de-Bigorre. He was the driving force behind the newly formed "Société Ramond" which, in 1866, established the first building at an altitude of 8,000 feet on the mountain. This building, in its ruined state, can be seen from the windows of the modern observatory.

Perhaps the most illustrious name in the history of the foundation of the Pic-du-Midi Observatory is that of General Nansouty, who himself lived at this altitude for six years—winter and summer—suffering considerable discomfort and hardship, to say nothing of the avalanches of snow from the mountain above. This experience convinced him that the best site for a permanent observatory



This aerial view of the Pic du Midi shows the entire observatory complex. Situated at 9,400 feet, this institution was founded by General Charles de Nansouty in 1882 to escape the problems of surface observation, and is still the highest astronomical installation making regular observations in various fields of celestial endeavor. Courtesy Pic du Midi Observatory.

A parka-clad astronomer observes with the 24-inch refractor, located in the large dome at Pic du Midi. On the same mount is the 15-inch refractor (top) and the Lyot coronagraph (below). Light entering large instrument is folded back to shorten tube, which would otherwise have to be 60 feet long to accommodate the long-focus objective.

Pic du Midi Photo

would be on the summit of the mountain, where avalanches could not occur. This suggestion fired the enthusiasm of another member of the "Société Ramond," Vaussenat, who toured France in an effort to raise funds for this work. In 1878, the arduous task of leveling the top of the mountain was started, backed by the 130,000 francs that he had collected.

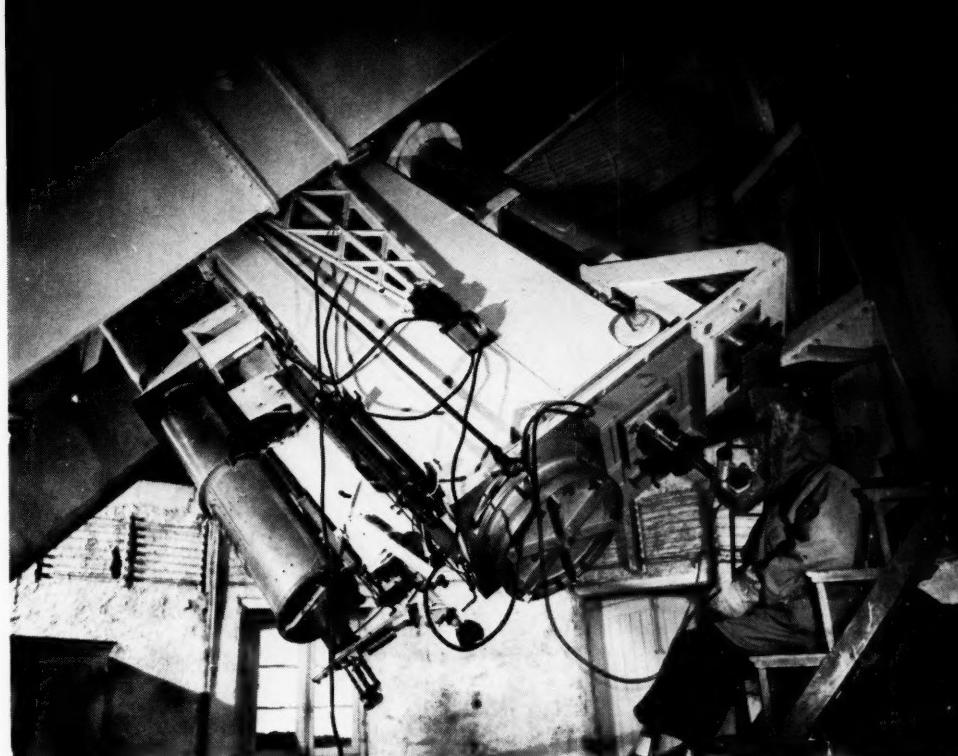
Meteorology is the "senior" science of the Pic-du-Midi, and in some ways this "overlaps" astronomy — particularly where sky conditions are concerned. It was not long therefore before it was noticed that, much of the time, atmospheric conditions were excellent, and this realization soon brought about the installation of a small astronomical telescope at the "Pic." Thus astronomers — among them such famous names as Lowell, the brothers Henry and others — came to the Pic-du-Midi.

During the intervening years the amount and variety of the work has continued to expand in what is probably the highest permanently manned observatory in the world, and it has become necessary to enlarge existing buildings and to construct new ones. In September when I was there, this work was progressing with greater momentum than ever before.

The Pic-du-Midi is closely associated with the University of Toulouse, and astronomers from here work side by side with others from Meudon Observatory, near Paris, and with astronomers and physicists from different parts of the world. It is in fact difficult to say how many scientific investigations are being pursued at the "Pic" at any one time.

Meteorological observations are made every day and automatic instruments relay the prevailing weather conditions to Toulouse, and, in return, messages are received that enable the men on the spot to construct weather maps covering the whole of Europe. These, of course, are most useful to the astronomer.

Owing to the fact that the altitude puts the Observatory above one-third of the earth's atmosphere — this lack of oxygen manifests itself when the newcomer attempts to run upstairs at



the "Pic" — and also above a good deal of the dust and smoke of the atmosphere, it is possible for astronomers to conduct researches that would be impossible at lower altitudes. An example of such a research would be the photographic studies of the solar corona that are carried out with a Lyot filter whenever conditions are good enough.

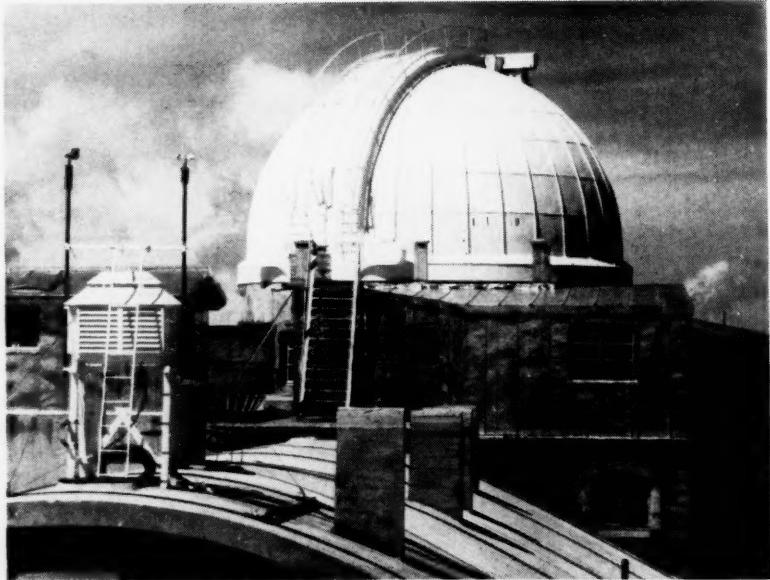
This instrument is an ingenious contrivance which, through the successive polarization of light beams, is able to select extremely narrow portions of the sun's spectrum. It is known that the solar corona is very bright at one particular wavelength of light, and the Lyot coronograph is "tuned" to this wavelength and photographs are taken that show the shape and extent of the solar corona. At lower altitudes such work would be spoiled by the scattered light from the sun's disc.

The Lyot coronograph shares the same "Carte du Ciel"-type mounting as — and is in fact fixed below — the famous 60-cm (24-inch) aperture and

This photograph of Mars is an example of what can be done photographically under the optimum observing conditions of the Pic du Midi. At top (south) is the south polar cap; mass at center is Mare Cimmerium; bright Hellas is at upper right above eastern edge of Syrtis Major.

18-metre focal length refractor, which is the biggest instrument at the Pic-du-Midi at the present time. This telescope is unique in several ways, for not only is the effective focal ratio large ($f/30$) — most refractors have focal ratios of the order of $f/15$ — but the construction of the instrument is more like a monocle, for, in order to keep the length of the tube as short as possible, light coming through the objective is made to pass up and down the tube three times. Thus, light admitted through the objective bounces off an optical flat situated at the lower end of the tube: this flat is inclined a bit, and directs the light into another flat just above the objective at the top of the tube: this, in turn, reflects the beam down to the observer, who is able to study





The "Grand Coupole," or Great Dome, which houses the two large refractors and the Lyot coronagraph. The neutron-counting equipment used during the International Geophysical Year is enclosed in the aluminum-clad hut immediately below the dome. Photo by the author.

it either visually or photographically. In this way the instrument is made more compact and maneuverable, also obviating the need for a very large dome to house it. On the same mounting, and just above this telescope, is a smaller 30-cm (12-inch) aperture refractor of about 6 meters focal length.

Another dome, situated roughly half-way along the collection of buildings that make up the observatory, houses the 60-cm Gentili reflector that has been used for stellar photometry. This instrument is due to be moved in the near future to make room for a large 40-inch reflector that is already under construction at the Arsenal at Tarbes, some short distance away.

Yet another newly constructed dome at the eastern extremity of the observatory houses a new coronagraph which embodies many new ideas, including a lens that projects outside the dome to avoid the effects of dome air-currents. This instrument is not yet in use, but the final coats of white paint were being applied to its "fireman's helmet"-shaped dome during my last visit.

Below the "Grande Coupole" that houses the 60-cm refractor there are wide-dispersion solar spectrographs. In these, light from the sun is deflected from the two mirrors of a clock-driven celostat outside the

building, and astronomers are able to select the solar area they wish to study and arrange for light from that area to fall onto the slit of a spectrograph. The light is then spread out into a broad spectrum made up of thousands of lines, each representing an image of the slit at a certain wavelength of light.

In the case of sunspots, some of the more prominent lines are displaced perhaps a little to the right or left of their normal positions in the spectrum. The amount of displacement is measured and, from this, astronomers are able to calculate the strengths of magnetic fields associated with the sunspots.

This is but one instance of the sort of work that these powerful astronomical tools are called upon to do. Before long, it is planned to remount the large 60-cm telescope so that the light from it can be directed on to the slits of these spectrographs, at which time astronomers hope these powerful and ideally located instruments will be able to unravel some of the mysteries of the less bright objects of the skies.

In addition to the studies of sunspots, the corona, and solar granulation, and our own photographic studies of the moon with the 60-cm refractor (see Sept.-Oct. issue), astronomers from Meudon have been developing a new form of camera—

an electronic camera which will enable them to take pictures of the fainter objects in the night sky with much shorter exposures than with the more conventional forms of photography. Furthermore, although the images are small, they are virtually grainless, too, so in the future we may expect to see detailed pictures of some of the more distant planets.

Much more could be written about the astronomical work of the Pic-du-Midi, but there are other activities that I must briefly describe.

During the International Geophysical Year a neutron-counting apparatus was installed at the "Pic," and this has been operating there ever since. Every now and again the sun is responsible for violent increases of radiation; when these sudden increases occur the neutron-counting apparatus records the results, and attempts are then made to explain this seemingly random behaviour of the sun. A close liaison is kept with other distant stations employed on the same task.

Ordinary cosmic radiation is about seven times greater at this height than it is at sea-level, and physicists from Imperial College in London have built a large Wilson cloud chamber to measure, not only the energies involved, but also the directions of individual particles as well.

Perhaps readers will be surprised to learn of the existence of a botanical garden at the Pic-du-Midi, here several hundred varieties of small shrubs and plants — among them primulas and saxifrages — have learned to adapt themselves to the short growing season that alternates with the interminable frosts, snows and gales of the Pyrenean winters and springs.

Television is the latest recruit to

Mr. Rackham is familiar to many of our readers as the author of the article "Scaling the Lunar Heights" in our Sept.-Oct. 1960 issue. A British amateur turned professional, he is currently engaged in the much publicized lunar mapping project under the direction of Dr. Zdenek Kopal at the University of Manchester in England. Much of his work is done at "The Pic," so he is especially fitted to do this piece—the first of a series describing the activities of observatories throughout the world.

Pic du Midi Observatory photographed from the cable-car terminal on the Col du Tauulet (altitude about 7,000 feet). Photograph taken by the author in August, 1961, when the mountain was free of snow.

the large number of activities that are pursued at the "Pic," and programs have been radiated from this lofty mountain for several years, but now the time has come to increase the power of the transmitter and to extend the range of the station. Since French television employs over eight hundred lines in the raster of its radiated pictures—the definition is excellent—this means that more information has to be transmitted on carriers of high frequencies and, in consequence, the television signals tend to travel in "optical" paths, and "shadows" exist for the receiving populations living close to local hills and mountains. The new television mast is located on the summit of the mountain and towers some 280 feet above its 25-foot-deep foundations which are cut and concreted into the solid rock of the mountain. The new mast and the more powerful transmitter will be in operation before this article is printed.

The incoming signal that is a re-radiated from the "Pic" transmitter is received on aerials placed at the focus of two metal parabolas. One signal comes in from Toulouse, the other from Bordeaux. The engineer sees both pictures on monitors in front of his control desk and is able to select at a moment's notice the better of the two signals, and this is the one that is radiated from the transmitter.

Television screens are a welcome addition to the limited recreational facilities of the Pic-du-Midi, and the television room is a favorite haunt of astronomers waiting for weather conditions to improve. Often the mountain is cut off from the outside world by gales and snow; it is then that television and radio programs are appreciated as alternatives to games of chess and checkers, reading, and an occasional game of table-tennis.

The French are justly proud of this Observatory, and the new building that is under construction on the summit at the present time will provide shelter for a large new telescope, and more living space for the people who work there.

There is no doubt that the members of the "Societe Ramond" would



have been very satisfied could they have seen the growth and development of the Pic-du-Midi Observatory under the able directorship of Dr. Roesch since World War II. Much work remains to be done, for an observatory is a living and evolving entity and something that is never

really complete or final. Nevertheless, the notable contributions that have been made in many fields of scientific endeavor through the facilities offered at the Pic-du-Midi augur well of the future, and the dream of Nanouty and Vaussenat has become a powerful reality.

MERCURY TRANSIT

An excellent series of photographs of the transit of Mercury across the disk of the sun on Nov. 7, 1960, was sent to us by four observers at the Brooklyn (N. Y.) College Observatory. Three of the photographs are reproduced below, showing the planet at and just prior to 3rd contact (the time when the planet begins to leave the sun's disk at the western limb).



The four students, Lawrence Jessie, Charles Aronowitz, Joel S. Levine and Robert Held, used a 7-inch Fecker refractor to time 2nd contact, then began their photographic program and timed the remaining contacts visually with the instrument's 3-inch guide telescope. Photography was done with a 35mm Praktica single-lens reflex, a Barlow lens and a Herschel wedge on the 7-inch, giving an effective working focal ratio of f/40. Exposure was 1/500 of a second on Microfile film.

A good Polaroid photograph of the event, taken through a 2.6-inch re-

fractor, was also made by three readers in Bergenfield, N.J.—Tom Kochakji, Martin Schulze, and Arthur Benedetti.

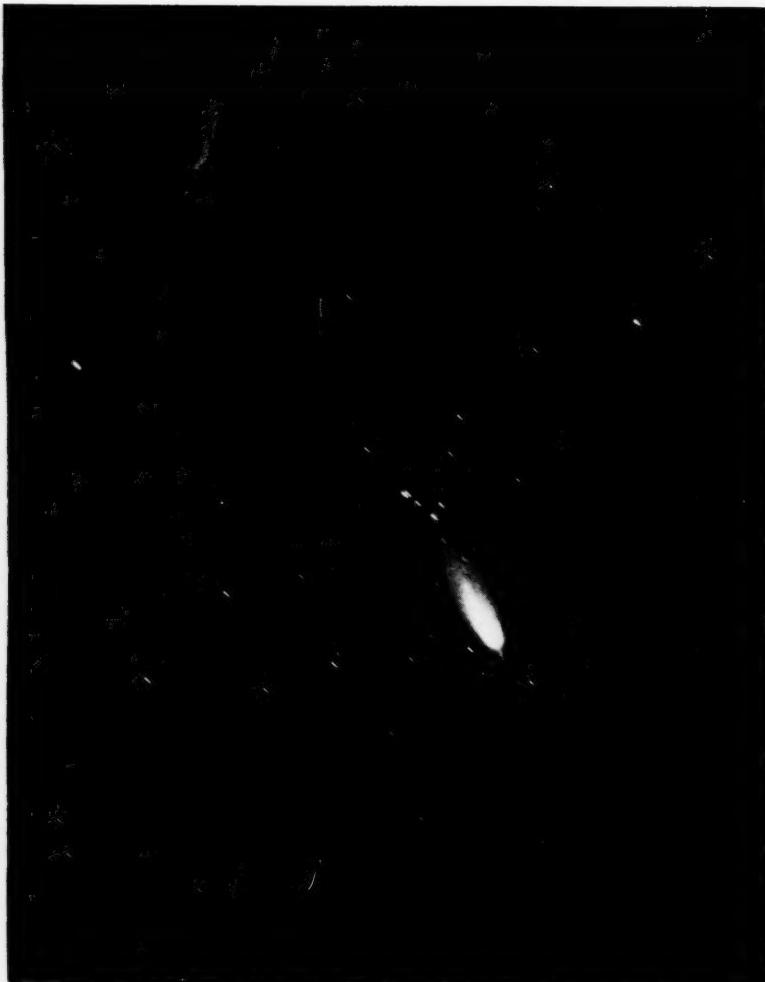
The University of Chicago High School's freshmen and sophomore science classes were treated to a closed-circuit telecast of the transit



of Mercury. The image formed by a 3-inch equatorially mounted reflector was projected into a shadow box 12 inches square and a television camera was brought to a distance of 18 inches from the projected image. This image of the sun and Mercury was then telecast onto the classroom TV screen to form an 8-inch-diameter picture of the phenomenon.

COMET ENCKE 1960i ... the "come-back" comet

DAVID MEISEL
Association of Lunar
and Planetary Observers



THE STUDY OF COMETS has had a colorful history. To the ancients, the comet was looked upon as an instrument of the gods to cast good or bad omens on man's activities, and their unorthodox appearance usually led the superstitious to describe them in the most imaginative terms. By the sixteenth century, comets were recognized by some observers as members of the solar system, but it was not until the eighteenth century that the foundations for the modern theories of comets were laid through the discussions of Fellows of the Royal Society in England such as Edmund Halley and Robert Hooke. Halley later showed that comets followed conic paths around the sun and made the first prediction of the return of the comet that now bears his name.

It is well known that the discovery of a new comet can bring quick fame to the discoverer. However, there are notable exceptions to the rule. One already mentioned is Halley's comet. Halley did not discover the object, but proved that various observations of certain bright comets dating back into antiquity were all of the same comet, having a period of revolution about the sun of about 76 years.

In modern times the renaming of Comet Pons-Coggia-Winnecke-Forbes for Professor A. C. D. Crommelin, whose extensive computations established its identity, is another example of the importance accorded theoretical and computational work in astronomy. Although Crommelin's work had long been recognized on the continent by frequent references to "Crommelin's comet," which appeared in the literature, it was not until the 1948 meeting of the International Astronomical Union that this title received official recognition, commemorating in a fitting manner the work of one of the greatest of all cometary astronomers.

One of the brightest and most interesting comets of recent memory was Comet Arend-Roland, which appeared in the spring of 1957. Overnight it developed a striking sunward spike which disappeared nearly as quickly. The effect was caused by debris scattered along the comet's path and seen by us edge-on for several days. This excellent photograph was made on the evening of April 25, 1957, at the Lick Observatory. Stars trail because camera and telescope were guided on the moving comet.

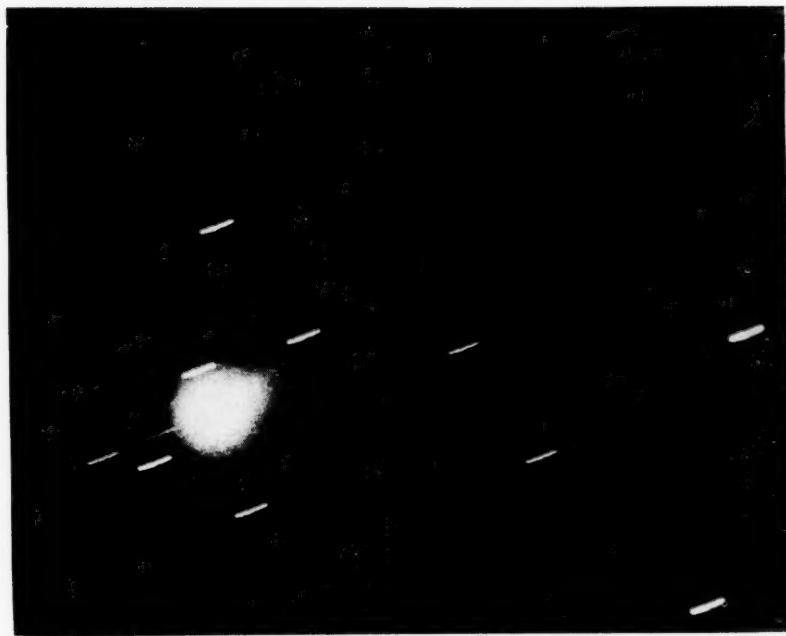
Comet Burnham 1959k, courtesy U. S. Naval Observatory, Flagstaff, Ariz. Compare this photo, taken Jan. 28, 1960, with small scale photo of same object on page 10.

Another instance is provided by Encke's comet, which has the shortest period of any comet that has been observed at more than one return. (Comet 1949g Wilson-Harrington has a period of 2.3 years but was only seen during one passage.) In 1818 the French comet-hunter Pons discovered a faint comet. Encke, who was at the time a student under Gauss, attempted to apply Gauss' method of elliptical orbit calculation to the new comet. Encke was not satisfied with this and went on to show that the comet was identical with Méchain's comet of 1786, with Caroline Herschel's of 1795, and finally, with Pons' discovery of 1805. He predicted a return in 1822 and the comet was recovered near its predicted position. It has since been seen at all of its 45 successive returns except the unfavorable return of 1944.

Encke's comet is important because of its orbital peculiarities. Sometimes called the Mercury of comets, this object's period is decreasing measurably, as is the period of that inner planet. During about a century the period of 3.3 years was found to have decreased a total of 2.5 days. The decrease is irregular as well, and causes a corresponding decrease in the long axis of the elliptical orbit. (This same period decrease, accompanied by the mean height decrease, also occurs for earth satellites such as Echo I which is falling closer to the earth at the rate of a few miles per day.) Calculations show that only a few thousand years ago Encke's comet path extended toward Jupiter's orbit, and it probably was deflected into its present orbit by a close encounter with the giant planet.

This famous comet was recently recovered by Dr. Elizabeth Roemer at the Flagstaff Station of the U. S. Naval Observatory on August 17, 1960, at magnitude 19.5. Object may be visible in small telescopes until it disappears into twilight late in January. It reappears in the morning sky in the middle of February. The comet reaches its closest approach to the sun (perihelion) of 30.5 million miles on February 5, 1961.

(Continued on page 10)



The following predictions of the positions of periodic Comet Encke (1960i) are adapted from a more extensive ephemeris computed by Dr. S. G. Makover of the Institute for Theoretical Astronomy, Leningrad, U.S.S.R. The original ephemeris was distributed by the Central Astronomical Telegraph Bureau of the International Astronomical Union in Copenhagen, Denmark. The magnitude estimates are based on a standard formula and should not be considered to be more than an indication of expected brightness. The comet will be in the twilight at its brightest apparitions before and after its closest approach to the sun (perihelion), another factor limiting its visibility to the observer.

The positions of the comet are given in right ascension and declination for 5-day periods. These positions are for 0h Universal time (U.T.), the standard time of the Greenwich meridian. Thus, the position in the ephemeris for Dec. 17, for an observer in the Eastern time zone of the United States, would be

A rapidly moving comet was discovered on Dec. 26th by M. P. Candy of the British Astronomical Association. Magnitude at discovery was 8.0. The comet was observed by D. Meisel and J. Jenkins on Dec. 31st in moonlight and was estimated at 7.7. The object is diffuse, 5' of arc in diameter, with no

(0h UT)		R.A.	Dec.	Mag.
Dec.	17	22h23m3	+ 5° 8'	12.0
	22	22 19. 8	4 28	
	27	22 18. 3	3 49	10.9
Jan.	1	22 16. 7	3 6	
	6	22 14. 4	2 17	9.5
	11	22 10. 4	+ 1 10	
	16	22 3. 4	- 0 31	7.6
	21	21 51. 3	- 3 8	
	(Too close to sun for observation)			
Feb.	15	20h18m4	- 24° 38'	5.7
	20	20 27. 3	25 7	
	25	20 39. 1	24 58	8.4
	Mar. 2	20 51. 6	24 29	
	7	21 3. 7	23 52	10.5
	12	21 15. 1	23 10	
	17	21 25. 8	22 26	12.0

its position on Dec. 16th at 7:00 p.m. (EST), or five hours earlier.

The comet may not show a tail or a bright nucleus, but merely an ill-defined "coma," making it an elusive object for the beginning observer with a small instrument. Low powers should be used, but not so low as to minimize the needed contrast of a dark sky. Averting one's view to another part of the field may help in locating the object and delineating faint detail.

tail but with a central condensation. Positions from tentative ephemeris are as follows (0h UT): Jan. 6, 22h 46m, +42° 50'; 11, 23h 01m, +38° 22'; 16, 23h 11m, +30° 25'. No magnitude predictions are available, but the comet may be brightening. Its path is carrying it through Lacerta and across the Square of Pegasus.

Comet Mrkos followed shortly on the trail of Arend-Roland in the summer of 1957, high and bright in the Milky Way. Recent computations show that this comet has a period of nearly 13,000 years. Photograph was made at Lick Observatory on Aug. 18, 1957.

(Continued from page 9)

Apparently associated with Encke's comet is a meteor shower called the Taurids. This shower is one of the so-called daytime showers discovered using radio-echo techniques. However, the changes in period and orbit shape have tended to mask the real connection between the two.

Many of us remember the sudden appearance of Comet Mrkos in August of 1957. Professor G. Schrutzka of Vienna has derived an elliptical orbit for this comet from two hundred and twenty-five (225) observations between August 4, 1957 and July 9, 1958. The period was found to be around 12,800 years! The orbit carries the comet out to a distance of a little less than 100 billion miles into space. Yet, this is a very minute distance from the sun as compared to the distance to Alpha Centauri, the nearest star other than the sun. Centauri is about 25 trillion miles away.

* * *

Many amateur comet hunters ask themselves, "What good are my observations?" This is a hard question to answer in a general sense. While it is true that the majority of amateur reports are severely limited by the ability of the observer, there appears from time to time work by amateurs that is of superior quality. At other times even fragmentary reports by inexperienced observers have filled in the gaps in a series of observations by other more experienced observ-

ers. Although searches for misidentified objects reported by well-meaning observers can be time-consuming, it is necessary that all reports be checked out.

Most amateur astronomers are usually satisfied just to look at the heavens, but a growing number of amateur observers delve a little further into things and may possibly be able to contribute data of scientific value. This is especially true in cometary astronomy. Traditionally, serious amateurs have played a part in the development of this branch of astronomy.

The work of the British Astronomical Association, among others, has demonstrated that the amateur can make definite contributions to cometary astronomy. The areas of contribution have included discovery, routine descriptive studies, photometry (both visual and photographic), and computation. Comments on these and other fields will constitute the subject matter of later articles when there is no current cometary

news. It is also planned to include interesting sidelights to current cometary research.

Comments and suggestions for possible topics for discussion are welcome and should be sent to the author. Observers are encouraged to submit reports of observations, drawings and photographs for possible inclusion in a future article.

Mr. Meisel is Comet Recorder for the Association of Lunar and Planetary Observers, for which work he was presented the ALPO Award at the Haverford College convention of the Astronomical League. He will continue to furnish news of current comets and discussions of comets of the past. Detailed reports of the ALPO Comet Section appear regularly in that organization's journal, THE STROLLING ASTRONOMER. Mr. Meisel is completing his undergraduate work in physics at the University of West Virginia, and plans to do graduate work in astrophysics.



Most recent naked-eye comet, Burnham 1959k, photographed by Alan McClure on April 8, 1960, with a Fecker f/7 triplet lens. Object reached 3rd magnitude in early May.

WE'RE LATE . . . AN APOLOGY

Owing to an unavoidable series of circumstances, the publication of this first issue of the new **Review of Popular Astronomy** was delayed by more than two weeks. We hope that our tardiness has not inconvenienced you unduly. With the March-April issue we will resume our regular date of publication — established with the Sept.-Oct. issue last year — which is the 25th of the month preceding the double-date of the issue. We will mail your copy at that time, and we would like to hear from you if the second-class mail service does not bring you your copy by the 1st of March.

We also hope that you will enjoy the many new features we will be adding during the next months, and that you will tell your friends about the magazine and suggest that they subscribe. We'll be happy to send them a sample copy of a current issue at no charge to them. We're certain they'll find it to be a useful publication.

THE EARTH IN SPACE

DR. I. M. LEVITT
Director, Fels Planetarium
Franklin Institute

On December 21, 1960, the sun reached its lowest declination south of the equator, and winter began in the earth's northern hemisphere. After this date the sun resumes its climb upward along the ecliptic toward the vernal equinox.

It is the motion of the earth around the sun which gives rise to the changing altitude of the sun. The axis of the earth is always tipped in the same direction in space—toward the North Star. As the earth moves around the sun, the axis leans toward the sun in the summer time, resulting in a high sun. It is tipped away from the sun in the winter, which means the sun is low in the sky. This motion of sun up and down in the sky, of course, gives rise to our seasons. But the surprising fact is that few people realize our earth is moving.

To most of its inhabitants the earth seems a fairly stable platform with little or no motion inherent in the body, though in their background consciousness they realize that eclipses, seasons and changing skies are due to motions of a sort. Actually, the giddy progress of the earth through space is so complex that astronomers have spent entire lifetimes trying to unravel the motions compounding its path.

Take the motions of a spinning baseball and a snake moving sinuously across a floor. Add the motion of a top that is slowing down and the motion of a corkscrew. Mix these motions well with those of a whirlpool, and the result will approach the indescribably intricate path of the earth through space.

The moon revolves around the earth once in the 29½ days of the month. Therefore, instead of the earth moving around the sun, it is the center of the earth-moon system which swings around the sun in a smooth path. That point is the barycenter, or center of gravity of the earth-moon system, and is 3,000 miles from the center of the earth in the direction of the moon. It moves around the sun in the orderly way that laymen think the earth does. But as the earth itself moves around this

center of gravity once a month, its path around the sun is a sinuous curve.

But this is only warming up to the subject of the earth's complex motions. There is another earth motion which labors under the rather unwholesome name of *precession*. Precession simply is the wobbling of the axis of the earth around the sun. In other words, the earth spins on its axis as it moves around the sun, but its axis doesn't stay in one position. It wavers like the stem of a top slowing down.

This wavering is due to the earth's not being a perfect sphere. Like many of its inhabitants, it has an "equatorial bulge"—its diameter at the equator is 27 miles longer than its diameter at the poles. The gravitational attraction of the sun and moon for this equatorial bulge tends to swing the earth down. That is, it tries to make the axis of the earth parallel the axis of its path. If the earth were a stationary body, this could be done. But because the earth is a spinning body, it behaves like a gyroscope. If you tip a spinning gyroscope to one side by pushing its spinning axis, it will move in a circle around its former upright axis. In much the same manner the earth's axis moves slowly in a circle around the axis of its path, making a complete revolution, once in about 26,000 years.

The earth is a part of the solar system and, therefore, shares the sun's motion in the local family of stars, which is part of the major star system we call the Milky Way, or galaxy. The sun in our galaxy may be compared to one of a swarm of bees in flight. The sun "bee" is moving with a speed of 12 miles a second in respect to its immediate neighbor star "bees." And, as our earth is moving around the sun, its path is a spiral, although technically it should be called a helix. Too, the entire swarm of bees is rotating.

Therefore, in addition to the motion of our earth "bee" with respect to its immediate neighbors, it also is rotating around the center of the



Dr. I. M. Levitt, director of the Fels Planetarium of the Franklin Institute in Philadelphia, poses below eyepiece complex of the Institute's Zeiss refractor during a visit of delegates of the Astronomical League to the institution in 1960.

moving swarm of celestial bees. The earth, of course, partakes of this motion of the sun around the center of the galaxy, the speed being 175 miles a second.

Finally, our galaxy is moving with respect to other galaxies at incredible speeds. In our bee analogy this represents a number of swarms of bees flying away from each other. The earth, of necessity, also shares this motion.

The next time you look up into the night sky, try to visualize some of these motions. It is a lesson in humility to realize that this tiny speck of cosmic dust, called the earth, is moving with motions almost without end.

THE REVIEW OF POPULAR ASTRONOMY is pleased to announce that the preceding article is the first of a series of contributions by Dr. Levitt on various important but often neglected aspects of astronomy. Director of the Fels Planetarium since 1949, Dr. Levitt's name has long been in the forefront in the intelligent presentation of astronomy to the public through syndicated newspaper articles, lectures, radio and television appearances and books. He received his Ph.D. in astronomy at the University of Pennsylvania. We are certain Dr. Levitt's popular discussions of astronomical phenomena will prove of great interest to our readers.



The great nebula in Orion, an impressive object in any instrument, from "naked eye" to 12-inch reflector. This photograph, made at the Lick Observatory, may be compared to wide-field plate made by Alan McClure for this issue's cover photo; south is at the top in this photo, as it would appear in an inverting astronomical telescope.

of a cold winter's night, when the stars crackle crisply against the black backdrop of the sky, does wonderful things to the heavens above us, clearing the air and causing the stars to dance in and out of place in a prismatic ballet of color and light. All very unscientific, you understand, but remember, it has been sights such as this that have caused man to wonder, to study, and to explain. Science—to know—followed curiosity—to wonder.

"What," mused the philosopher, "would man think if the stars would come out but once in a thousand years?" Well, we answer, a bit late, this would be up to the individual man. But for ourselves, and assuming a bit of advance information, we would chose to have this celestial event occur in late winter, with Orion high in the southern sky. And what would we see?

We would see nearly half of the 1st-magnitude stars, and we would see them within our little 60° hole in the trees above us! Red Betelgeuse, of the exotic pronunciations; blue Rigel, 10,000 times more luminous than our sun; and low-lying Sirius, always dancing up and down the rainbow in northern climes, confident of its unique position as the brightest star in the skies. Then up to Procyon, the "Little Dog Star"; Aldebaran, causing even Betelgeuse to pale against its ruddy hues, but then giving way, in turn at least for these months, to a rival "star" in Gemini above, the crimson planet Mars; then to Castor and Pollux, the celestial twins forming the heads of Gemini. Peeking through the winter-bared branches at our zenith then soars yellow Capella, guarding a herd of open clusters, and finally, almost forgotten in the glare of Sirius, is the little known 1st-magnitude star Adhara (Epsilon Canis Majoris, -1.48).

This impressive listing is enough to warrant a trip into the cold, but these stars are fairly rivaled by the other stars among them. The entire field of stars in the Canis Major-

THROUGH THE THREE-INCH

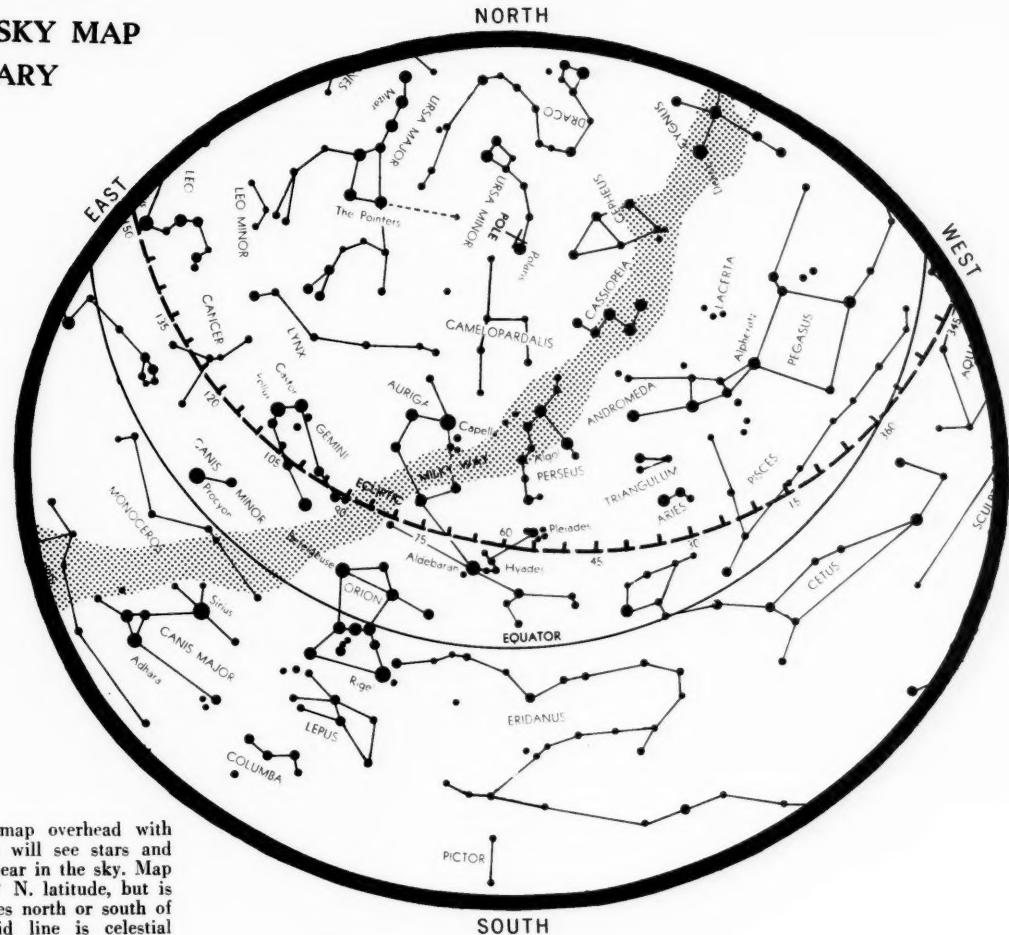
Our backyard has gone back to nature. Where only a decade ago the greater portion of the skies unfolded before us each evening, little hedgerows now loom up to block the view and the aging elms and maples have asserted their maturity. Perhaps this is nature's way of teaching us patience—everything in its place and in its time—for now we must wait for the stars to come to us. All that is left of the firmament from where we see it is a strip from the zenith to about 20° above the southern horizon—a band of sky 60° wide.

At best it is like being trapped in an observatory with the rotating dome stuck tight. At worst it is like operating a meridian transit, the small telescope used by positional astronomers in determining exact places of stars and correct sidereal time. These telescopes are always used on the north-south meridian

line, only moving up and down in altitude as appropriate stars reach their culmination on the meridian. But, as the English poet said, "the unheard songs are sweeter," and when bold Orion and his retinue move majestically into our little clearing in the wilderness, the sound of silence is deafening.

For the majority of our readers, winter stargazing can be measured in fragmentary bursts, and we will not allow for a moment that any of our readers can stroll out onto the patio in their shirtsleeves, drop into a deck chair and survey the winter skies. Possibly it is this very rarity of opportunity (or cowardice of flesh) that gives Orion and his neighbors their very special place in our mind. The stars of spring, summer and fall are old friends, with few surprises, but we still become excited when Orion first climbs from his lair in the east. We know that the magic

EVENING SKY MAP FOR JANUARY



Face south, hold map overhead with north at top. You will see stars and planets as they appear in the sky. Map is designed for 40° N. latitude, but is practical ten degrees north or south of that latitude. Solid line is celestial equator; dashed line is ecliptic, the apparent path of sun and planets.

9:30 p.m., Jan. 1 8:30 p.m., Jan. 15 7:30 p.m., Jan. 31

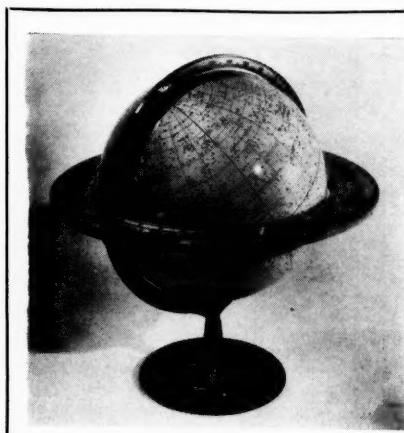
Orion-Taurus-Gemini strip is in itself unmatched. To watch it for long is to reel—spotted within the confines of these winter groups, comes a third dimension of observing pleasure in the form of some of the sky's most enchanting sights—the Pleiades, the Hyades, the Great Nebula in Orion, the Crab Nebula in Taurus, and a profusion of great clusters.

But of all these, none offers the small instrument as much delight as Messier 42—the great nebula of Orion. Contributing editor Walter Scott Houston has the following comments on this splendid object:

"Not much optical aid required . . . a pair of binoculars shows it better than most nebulae in a 6-inch. In a 3-inch glass at low powers it is a truly remarkable object, with great, curving sheets of luminosity

stretching out like celestial plumes. Near the center is a dark area of

obscuration, irregular in shape, and with the prominent little grouping of



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stars that forms the well known Trapezium.

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"Natural color photographs suggest the greenish glow recorded by so many observers to be a physiological illusion. Color photographs made at Palomar in 1958 show that these vast sheets of gas are primarily either rose-red or dusky purple, the colors caused by electrically stimulated atoms of oxygen and nitrogen.

"Regardless of the cause, however, the average observer is content to marvel at the intricate patterns of these flowing clouds of tenuous gas, thinner in most places than the vacuum in your radio tubes. To add that this gaseous network stretches out for thousands of light years adds little to the magnificent visual spectacle of the Orion nebula."

—D.D.Z.

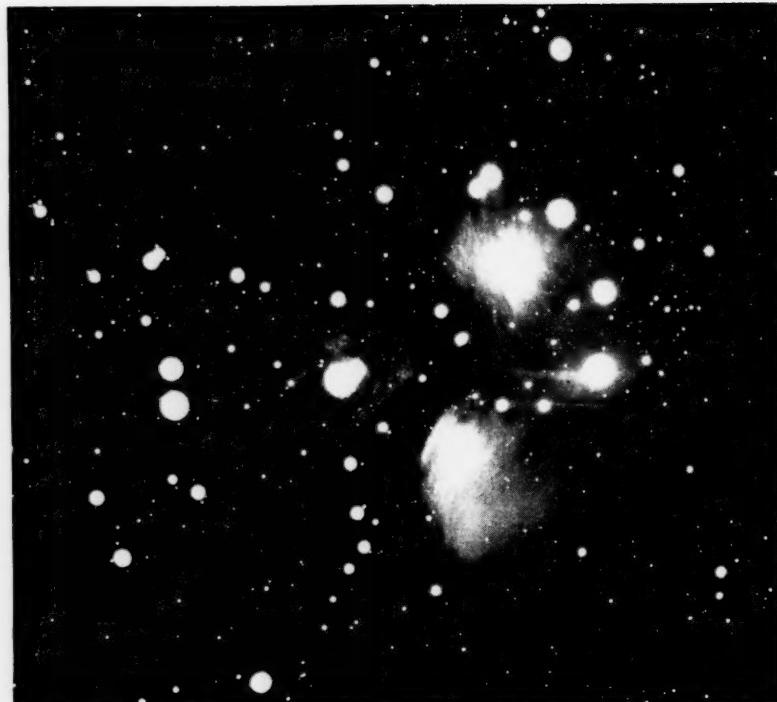
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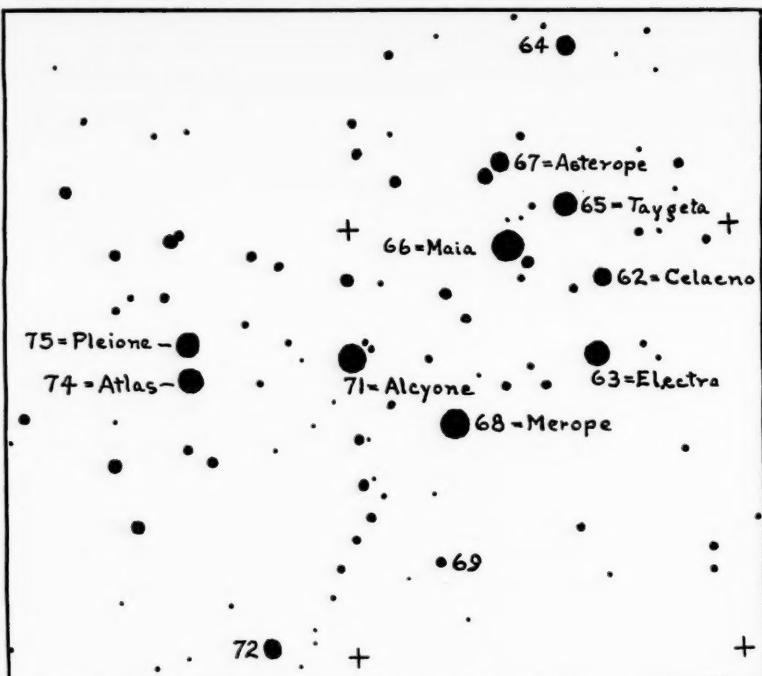
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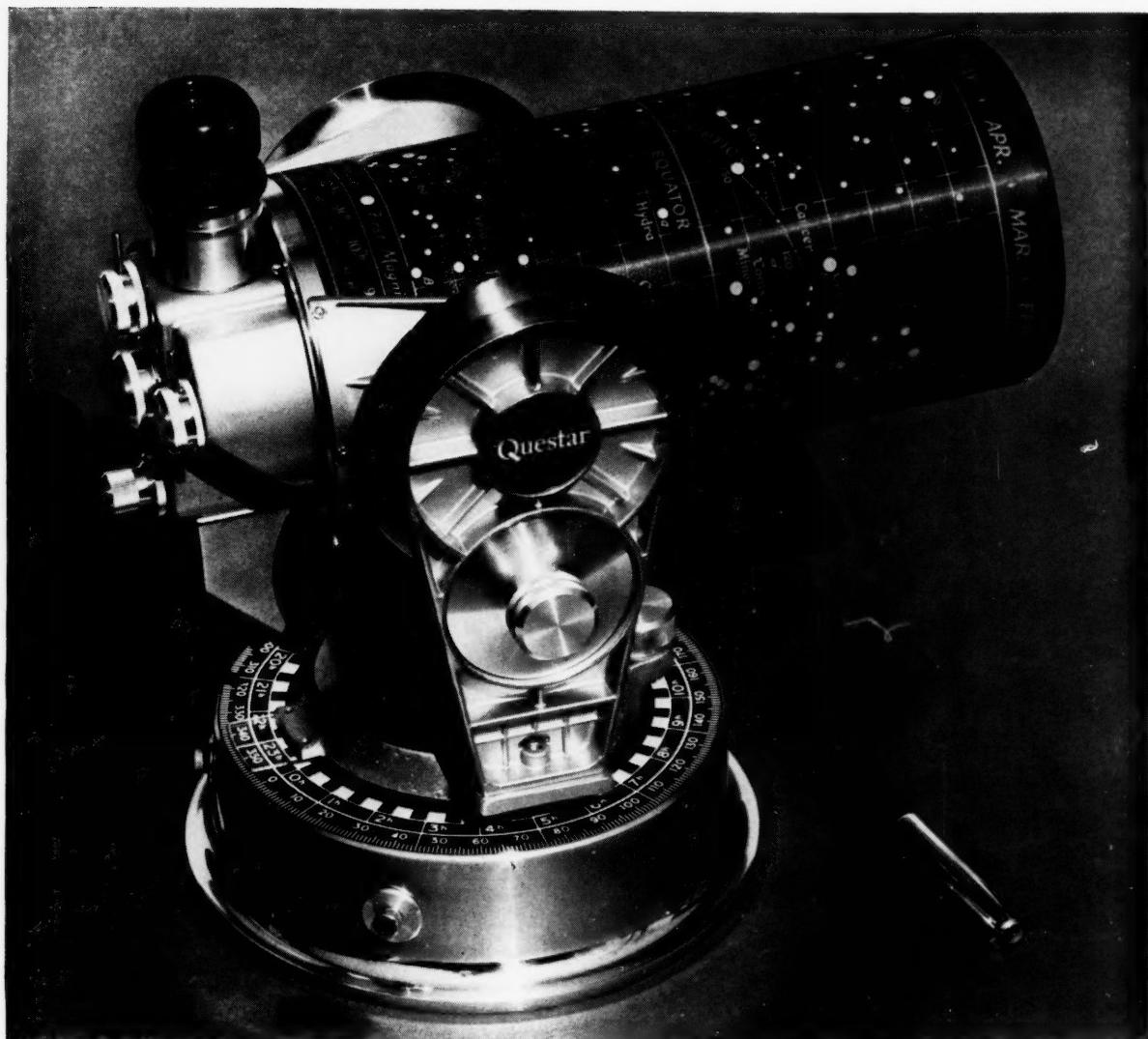
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The Pleiades, another exciting winter object, pose for the trained camera of astrophotographer Alan McClure. Prominent is the nebulosity enveloping Maia and Merope. Chart below shows names and magnitudes of Pleiades stars (decimals eliminated to avoid confusion with stars) and is on same scale as photo. Adapted from chart in Barnard's "Atlas of Selected Regions of the Milky Way," Carnegie Institution, Washington, D. C. A three-inch telescope under low power will offer the amateur many hours of rewarding study in this star-packed area of the sky. Small instruments often show associated nebulosity surrounding Pleiades.





LAY THAT BURDEN DOWN

When you finally get tired of lifting and carrying your telescope in and out of doors, tired of setting it up and taking it down in chilly darkness—

When you've had enough of heavy loads, of quivering tubes and images, enough of drives that falter and slow motions that fall short—

When you finally realize that it has become too much trouble to use your telescope any more because it only gives you an aching back and a pain in the neck—when you've had your fill of the contraption—*send for the Questar booklet!*

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-
1. October 12, 1960, 8:00 UT, CM: 32° . S: 6, T: 5. Power 375x.
Southern hemisphere dull and featureless. Sinus Meridiani darkest, then Sinus Margaritifer, and Sinus Aurorae. Pyrrhae Regio well developed. *Ganges* broad and diffuse. Lunae Lacus hazy. Mare Acidalium prominent but not too dark.
2. October 28, 1960, 9:30 UT, CM: 263° . S: 7, T: 4. Power 375x.
Northern tip of Syrtis Major darkest. *Crocea* bright, center of Hellas bright. Thoth broad and dark with two condensations. *Sinus Gomer* shown as thin, dark line. Moeris Lacus very small, Nepenthes faint.
3. November 18, 1960, 5:00 UT, CM: 3° . S: 6, T: 5. Power 375x.
Mare Acidalium more complex than before, Sinus Meridiani darkest part on disc. *Xisuthri Regio* indicated? Edge of North Polar Cap irregular.
4. November 22, 1960, 12:00 UT, CM: 68° . S: 5, T: 3 (morning twilight), 375x.
Candor — Tractus Albus very bright, forming large Y, almost fused with northern cap. *Ganges* broader and darker than before. Lunae Lacus very conspicuous and dark. Thaumasia fainter than Sinai. Solis Lacus not too well-defined. Nectar narrow, Tithonus Lacus diffuse. Ceraunius and Phoenicis Lacus indicated but vague.
5. November 24, 1960, 5:00 UT, CM: 308° . S: 6, T: 5. Power 375x.
Syrtis Major as before, Meroe set-off from Aeria by faint shading. Nilosyrtis and Ismenius Lacus prominent and dark. Sinus Sabaeus and Mare Serpentis obvious. Hellas has bright center.
6. November 27, 1960, 9:00 UT, CM: 339° . S: 5, T: 3. Power 250x.
Sinus Meridiani not as dark as before, Sinus Sabaeus seems darker. Ismenius Lacus, Deuteronilus, Oxus, and Cydonia are very complex in shading. Indication of Pandorae Fretum. Mare Acidalium dark.

Drawings of Mars made with the 8-inch refractor of the Kellogg Observatory, Ernst E. Both. S: seeing, 10 best. T: transparency, 5 best. Italics indicate Antoniadi's nomenclature. Accompanying notes by the author.

MARS — A MID-OPOSITION REPORT

ERNST BOTH
Kellogg Observatory
Buffalo Science Museum

Now that the favorable oppositions of 1954, 1956, and 1958 are part of the observational history of the planet Mars, we are moving toward four unfavorable, near-apHELIC apparitions which, because of the relatively small apparent diameter of the planet, almost certainly will be poorly observed. Most of our knowledge of our neighboring planet pertains particularly to its southern hemisphere and was gained during favorable periHELIC oppositions such as those of 1877, 1894-96, 1909, 1924, and 1954-56. Since during these approaches Mars had its northern pole turned away from the earth, our knowledge of the areography and areophysics of its northern hemisphere shows many gaps which, however, could partly be filled during the coming, less-favorable apparitions by amateurs possessing larger apertures.

Compared with the opposition of 1958, the apparent diameter of Mars was smaller by about 4" of arc (15".36) on December 30, 1960. Mars being actually closest on Christmas Day, when it was distant from the earth by 56,370,000 miles. Since at date of opposition the latitude of the center of the disc is 2°.24 north, both northern and southern hemispheres will be almost equally well presented. Somewhat earlier, on December 8, 1960, spring will have started in the northern hemisphere of our red neighbor, so that observers will be able to watch the gradual shrinkage of the northern polar cap, or, with the southern hemisphere moving into its fall season, the process of formation of the southern cap can be followed closely.

At the Kellogg Observatory of the Buffalo Museum of Science, systematic observations were begun during October with the observatory's 8-inch Lundin refractor, the apparent diameter of Mars then being about 9" of arc. Although Mars could be successfully observed on only eight nights, careful planning made it possible to secure 20 drawings, covering almost the entire observable surface. During most of October the southern hemisphere appeared quite dull and

Mr. Both is curator of astronomy at the Buffalo Museum of Science and director of that institution's Kellogg Observatory, the main instrument of which is an excellent 8-inch equatorial Lundin refractor housed in a dome on the museum roof. He is also Mars Recorder and Foreign Language Coordinator for the Association of Lunar and Planetary Observers. His particular interests are Mars and the moon, and was greatly influenced by his work in Germany under Dr. K. Graff, well known Mars student and co-author of the excellent Beyer-Graff Atlas. He has taught at the University of Buffalo and Washington University in St. Louis.

opaque, and judging from filter comparisons it is possible that a localized "dust storm" was taking place (at that time it was mid-summer on southern Mars). The most prominent feature of the northern hemisphere was, of course, the polar cap, whose behavior was carefully followed at Buffalo. Equipped with a 10-inch Cave reflector, Clark Chapman, a young ALPO member, was able to follow Mars as far back as May, 1960. According to his observations, the northern polar cap had an average diameter of about 40° during September, but it increased rapidly in size, and by the middle of October and most of November it had reached and maintained a comparatively stable average of about 65°. A surprising maximum extent of 75° was observed around November 22. On that date I was able to make three drawings (CMs 32°, 54°, and 68°), all of them showing the north polar cap larger than ever before, with most of the disc north and west of Solis Lacus (using the new IAU nomenclature, unless otherwise indicated) quite bright and blank.

This unusual size of the northern cap was almost certainly not due to surface deposits or even low white

clouds, but seemed to be primarily the effect of atmospheric conditions prevailing at greater altitudes. Comparative observations with red and orange filters showed the cap to have a diameter only 70% of that visible in deep blue filters. Furthermore, the brightness of the northern cap as seen visually and in blue light was not uniform, but showed local variations. During October and November the cap was always prominent but never dazzling. It seems safe to say that during this period the nucleus of the northern cap consisted most likely of surface deposits and/or low level condensations, while cloud-like veils at greater altitudes were responsible for the maximum size.

Turning to the dark areas of the planet, their behavior was very much what one might expect. Perhaps the darkest object on the disc was the triangular Syrtis Major, at least its northern tip. At its southern opening the bright streak reaching toward Hellas (the "Crocea" of Antoniadi's map of 1930) was always well seen, although its brightness seemed to be variable. Hellas itself was rather bright near its center and showed no other detail. The abnormal enlargement of Thoth, which attracted world-wide attention in 1954 and 1956, was still present, although fainter than before and somewhat smaller. Toward the south it was connected with the Mare Cimmerium (Antoniadi's "Triton"), while in the north Casius connected it with the Nilosyrtis. Thoth itself seemed to consist of two darker condensations.

The Maria Sirenum and Cimmerium presented nothing unusual; they were generally dark and well presented. Slipher's "Sinus Gomer" (north of Cyclopa), as well as Cerberus, were quite obvious, the Trivium Charontis being only slightly enlarged. Toward the zero meridian the large "desert" areas of Aeria, Arabia, and Moab were generally featureless, but Meroe was distinctly more bright and separated from this "continental block" by a faint shading (Antoniadi's "Astusapes"). Nilosyrtis, Protonilus, and Isemenius

Lacus were present but somewhat dull during October. In November they appeared darker and Oxis, Deuterionilus, and Cydonia became more conspicuous and complex. The latter area presented a complex appearance on November 27, CM 339°.

Near the equator Sinus Sabaeus at times showed white condensations parallel to the equator (November 18, CM 3°, perhaps the "Xisuthri Regio" of Antoniadi), but for the most part it was dark, though not as dark as the forked Sinus Meridiani. The Mare Serpentis was always well seen, but Pandorae Fretum was generally absent or only vaguely indicated; in other words Deucalionis Regio seemed to be fused with Noahis.

Most of the activity was evidently taking place around the Mare Acidalium and Solis Lacus. In this general area Antoniadi's "Ganges" was very broad and quite dark, with the Lunae Lacus prominent and enlarged at all times. This oval "lake" seemed

to gain in prominence during mid-November, with the Nilokeras almost as broad as "Ganges". The Mare Acidalium at first was rather hazy but became likewise darker toward the end of November, the following end usually being darker than the preceding one. Of particular interest was the conspicuousness of the bright Candor-Tractus Albus areas, which always looked like a large, white Y. Solis Lacus was diffuse and small. Nectar generally vague. The Coprates-Tithonus Lacus complex seemed to be well indicated, though not too prominent. Usually Thaumasia was fainter than Sinai. Toward the end of November a vague Ceraunus and Phoenicis Lacus began to emerge. The rest of the area toward Cerberus was somewhat dull and featureless, faint shadings being suspected at times.

While so far the current apparition has not produced any startling changes, it would be important to follow the development of "Ganges".

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Lunae Lacus, and Nilokeras with particular care. Central meridian transits of selected and well-defined surface features should be attempted near opposition and these should be sent to some central agency, such as the Mars Section of the Association of Lunar and Planetary Observers. As its present Mars Recorder I would welcome any observations.

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... journal of the Association of Lunar and Planetary Observers.

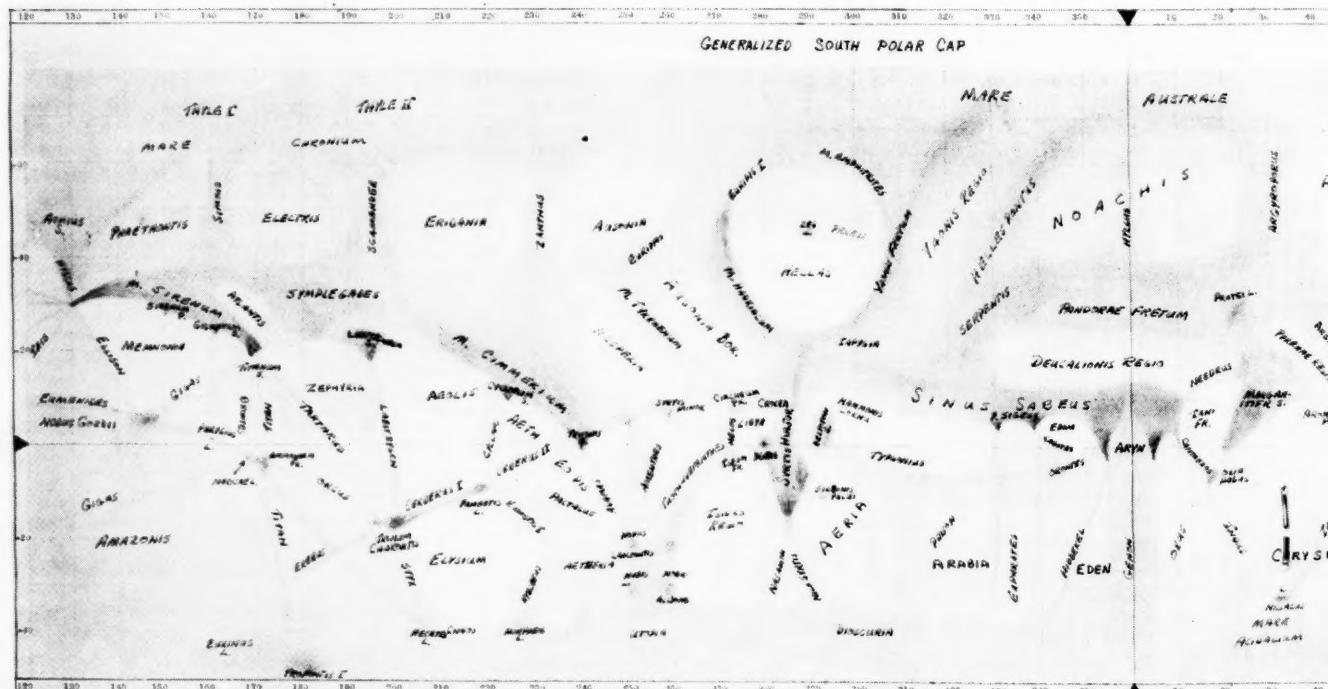
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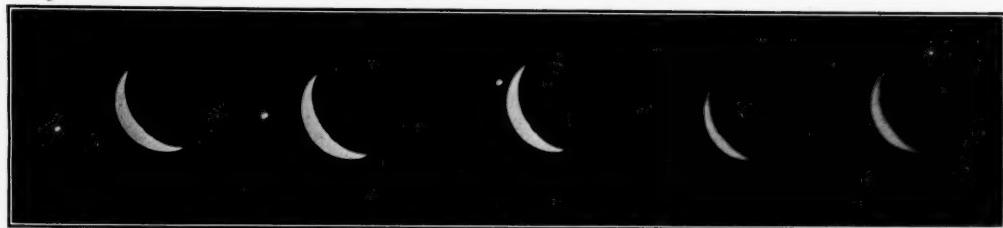
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The chart of Mars below, reprinted for the readers' convenience from the Nov.-Dec. 1960 issue, was reproduced from a map of Mars made during the 1958-1959 opposition of Mars by Frank Vaughn, then Mars Recorder of the Association of Lunar and Planetary Observers. By referring to Martian longitude and latitude lines on chart, observers can relate both's drawings on page 16 to overall view on Vaughn's map. Reproduced courtesy of ALPO.



Venus occults the moon, Jan. 13, 1923.
Photographed by William Henry,
Brooklyn, N. Y.



OCCULTATION TIMING . . . a field for the amateur

AT FIRST GLANCE, an observer would assume that an occultation—the phenomenon which occurs when the moon occults, or passes in front of, a star or planet—would be a relatively commonplace celestial event. All the stars in the sky, we say, and that big moon up there—an occultation must be observable every few minutes. But this is far from the case, for many factors weigh against this supposed frequency.

For example, the occultation observer is at once limited by the number of bright stars within the range of the moon's path—approximately 2,300 stars of magnitude 7.5 or greater. (Occultations of stars fainter than 7.5 are either unobservable or of little use because the occulted star will probably not have had accurate positions determined for it.) Of

course, in any one year the moon does not occult all of these stars, since the range of the moon's path extends about $6^{\circ}.5$ north and south of the ecliptic, yet the moon itself is only half a degree in diameter.

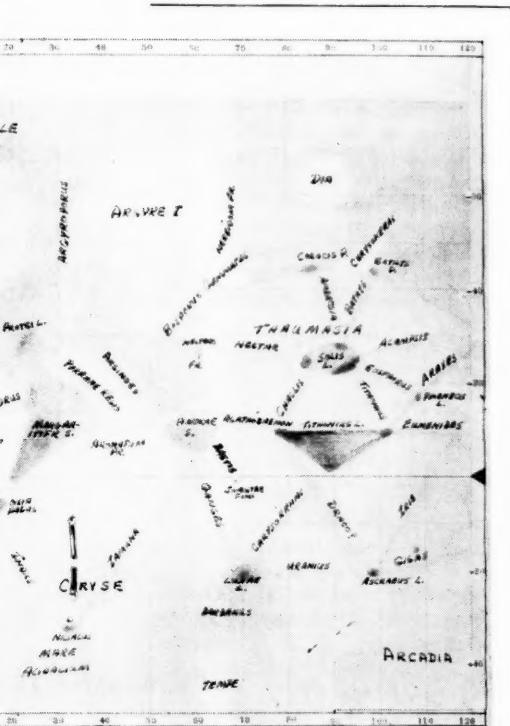
Even further restrictions exist, however. The fuller the moon's phase, the greater influence the problem of glare has on the limiting magnitude observable. At full moon a third magnitude star is just visible in a small telescope, while under the most favorable conditions a 7.5 star is easily observable. Thus lunar phase is important, with the added factor of bright or dark limb being a further consideration. When a star disappears behind a dark limb, it is more readily visible than the same star being covered by the bright edge of the moon. So, before full phase the moon, in its west-to-east motion against the stars, occults stars with its *dark* limb, while after full moon stars are occulted by the *bright* limb, which limits observation of the fainter stars. Another limitation must then be allowed for, since the accurate observation of a star's reappearance is predicated upon the observer's ability to catch the emerging point of light at the moment it reappears. A star at the limit of visibility can be located and followed successfully to the point of disappearance, but the same star cannot usually be located at the very moment of *reappearance*. Thus stars fainter than 6.5 are eliminated in predictions of emersions, or reappearances.

But further limitations must be applied. Occultations occurring near the horizon must be limited to the brighter stars, since atmospheric diminution takes its toll of a faint star's apparent brightness. Also, at any one point an observer is restricted to stars which are above the horizon and which are in a sufficiently dark sky. And finally, there's the weather! So we see that our 2,300

occultable stars reduce to less than one-half of one percent actually observable from one place on earth during one specific year—and this figure is further narrowed by the local weather conditions and the observers' enthusiasm and ability. As an example, there will be less than 100 predicted lunar occultations observable from the vicinity of Washington, D. C., during 1960 (although eight of these include both disappearances and reappearances).

Nevertheless, observations of these occultations are of value, as well as being instructive and absorbing for the observer. Procedures for making useful occultation observations are comparatively simple. A small telescope (2-6 inches) is ideal, and a medium-power eyepiece, giving a magnification which keeps the lunar image slightly smaller than the field of view of the telescope, completes the instrumental requirements. Of course, the occultation must be timed with a fair accuracy—at least to the nearest second—but a recording chronograph or chronometer watch is not required. When the star is occulted, or emerges from occultation, a stopwatch is started, and then stopped at the next convenient minute, as indicated by a clock which has been set by time signals from short-wave station WWV. (This correction to the clock can also be applied *after* the stopwatch has been stopped.) After this has been done, it is necessary only to subtract the elapsed seconds on the stopwatch dial from the corrected clock time to obtain the time of occultation.

Another method, more accurate and less susceptible to error, is that of using a short sound pulse (or pencil tap) transmitted to a tape recorder operating at its fastest speed. The time signal pulses from WWV are also superimposed on the same tape, together with the 5-minute voice announcements (for a reference point). When the occultation "blip"



is on the tape, the tape is then monitored at a slower speed (if available), and when the blip (or tap) is located and the time (h.m.s) established, an estimation is made of the fraction of the second.

Predicting the time of occurrence of occultations for certain standard station locations is the business of H. M. Nautical Almanac Office at the Royal Greenwich Observatory, Herstmonceux Castle, England. Effective with the unification of the

British and American Nautical Almanacs, which are now a cooperative venture of the two offices, times of occultations for these standard stations are no longer included in these annual publications.

POPULAR ASTRONOMY has been given permission by Her Majesty's Nautical Almanac Office at the Royal Greenwich Observatory to publish a selected list of these occultation predictions for the two-month period of each issue. (An advance list of all

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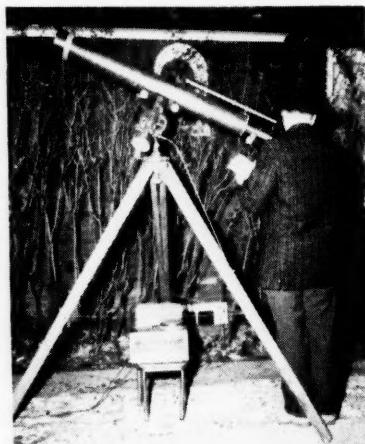
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observer improves with experience," Mrs. Sadler added, suggesting that the beginner first "make observations of disappearances at the dark limb, and then go on to reappearances, and only after gaining some experience of these dark limb observations should he start making bright limb observations."

Mrs. Sadler also explained that visual observations of occultations are being used at the present time for refining lunar time-position information. Corrections are being applied to the observations to allow for the irregularity of the moon's limb, improving the weight which can be given to the timings and enabling the observations to be used in research on the moon's motion and its orbit.

Observations of occultations should be sent no later than six months after the end of the year to H. M. Nautical Almanac Office, Royal Greenwich Observatory, Hailsham.

Sussex, England. Reports should include the observer's name and complete address; the Zone Catalog designation number and magnitude of each star observed; disappearance or reappearance; Universal time and date of the occultation; useful data such as aperture and type of telescope, magnification used, description of timing method, and pertinent information as to observing conditions; and finally, the latitude and longitude of the place of observation to the nearest second of arc, which is about 100 feet, and height of the observing position above sea level. Observers east of the Mississippi River can obtain appropriate topographical maps from the Map Information Office, U. S. Geological Survey, GSA

Building, Washington 25, D. C.; those west of the Mississippi can write the same office at the Denver Federal Center, Denver, Colo. Maps covering the observers' region can be obtained for 30c per sheet. Canadian observers can obtain similar maps through the Department of Mines and Resources, Ottawa, Ontario.

Information on time signal frequencies and procedures for station WWV may be obtained from the Radio Standards Division, National Bureau of Standards, Boulder, Colo., and for Canadian station CHU from the Dominion Astrophysical Observatory, Ottawa, Ontario.

Adjacent to this article are the occultation predictions for January–February 1961, covering standard

stations in the U. S. and Canada. Only occultations of stars brighter than magnitude 5.0 are included. Since the time of occultation will vary for any point other than the station for which the predictions are given, corrections for the observer's longitude and latitude must be made if the local time of the event is to be approximated. The method for making these corrections is given in the material accompanying the predictions, with an example to guide the observer who is unfamiliar with this process. Corrections are useful within about 250 miles of a standard station, but observers should prepare themselves in advance of the predicted time.

—D.D.Z.

Station & Location Long. Lat. West North	Date (1960)	Name & Cat. No.	Mag.	Phen.	Age of Moon	Time (EST) h m	Correction Long. Lat.		Position Angle
							Long.	Lat.	
A	72°.5 42°.5	Jan. 10	74 Virginis 1941	4.8	R	23	03 39.4	-1.5 +0.7	279°
B		26	Gamma Tauri 635	3.9	D	9	01 09.1	-0.2 -1.6	100°
C	73°.6 45°.5	Jan. 10	74 Virginis 1941	4.8	R	23	03 39.8	-1.3 +0.5	287°
		26	Gamma Tauri 635	3.9	D	9	01 04.1	-0.3 -1.5	92°
D	77°.1 38°.9	Jan. 10	74 Virginis 1941	4.8	R	23	03 28.3	-1.7 +1.5	262°
		26	Gamma Tauri 635	3.9	D	9	01 14.8	-0.2 -2.1	115°
E	79°.4 43°.7	Jan. 10	74 Virginis 1941	4.8	R	23	03 30.9	-1.3 +1.1	275°
		26	Gamma Tauri 635	3.9	D	9	01 05.0	-0.4 -1.7	101°
F	91°.0 40°.0	Jan. 10	74 Virginis 1941	4.8	R	23	03 10.8	-1.1 +2.4	249°
		26	Gamma Tauri 635	3.9	D	9	01 06.9	-0.7 -2.6	121°
G	98°.0 31°.0		No occultations						
H	105°.0 39°.7	Jan. 26	Gamma Tauri 635	3.9	D	9	00 55.0	-1.3 -3.4	130°
I	109°.0 34°.0		No occultations						
J	113°.1 53°.5	Jan. 22	Nu Piscium 249	4.7	D	6	19 32.0	-1.4 +0.1	96°
		26	Gamma Tauri 635	3.9	D	9	00 19.3	-1.3 -0.6	80°
		26	71 Tauri 661	4.6	D	10	04 10.9	+0.2 -2.9	134°
K	120°.0 36°.0		No occultations						
L	121°.0 42°.5	Jan. 26	Gamma Tauri 635	3.9	D	9	00 18.8	-2.2 -2.2	116°
M	123°.1 49°.5	Jan. 26	Gamma Tauri 635	3.9	D	9	00 06.1	-1.7 -0.5	90°
		26	Theta-1 Tauri 669	4.0	D	10	05 13.9	-0.1 -1.1	76°
		26	Theta-2 Tauri 671	3.6	D	10	05 15.8	0.0 -1.6	97°

HOW TO USE THESE OCCULTATION PREDICTIONS

Predictions are made by H. M. Nautical Almanac Office for 12 stations in the United States and Canada. Some of these stations actually lie within certain large cities, but others are merely selected for geographical location and do not coincide with specific cities. Unless you live within a few miles of the points designated by longitude and latitude coordinates of one of these standard stations, corrections must be made to the times given in the above lists.

First, the longitude and latitude of the nearest standard station must be subtracted from your own longitude and latitude. If you are north of the standard-station latitude or north of the standard-station longitude, the sum will carry a minus sign. The difference in longitude is then multiplied by the longitude correction figure given in the tables for your standard station; likewise for the latitude correction. These two quantities are then added, being careful throughout to take into account the plus and minus signs. The sum of these two numbers will be your corrected factor for that occultation, and is subtracted or added, as the signs demand, from the listed time of occultation. These times are only a guide, however, and you should be prepared to begin observations a few minutes in advance of the predicted time.

Occulted stars are designated in most cases by constellation and appropriate Greek letter designation or Flamsteed number. In some cases the Bonner Durchmusterung catalog number (e.g., 57° 485) is used for fainter stars. Only stars brighter than 5.0 are published in this selected list. Complete predictions of all observable occultations are published in advance for each year in the December issue of SKY AND TELESCOPE magazine.

The column under "Phenomenon" shows whether the occultation is a disappearance (D), a reappearance (R), or a grazing occultation (G), which may or may not occur for a particular station. Age of the moon is given in days from new moon, and the position angle on the limb of the moon is given in degrees. Position angle is measured eastward from north; orientation can be determined by letting the moon drift through the field of view to establish the east-west axis. Be certain to allow for inversion by the telescope: in a normal situation, looking generally southward from the zenith, north (0°) will be toward the bottom of the field; south (180°) at the top; east (90°) at the right; and west (270°) at the left.

Observations should be sent, as soon after the end of the year as possible, to H. M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, England.

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BOOK REVIEW

**OUTER SPACE PHOTOGRAPHY
FOR THE AMATEUR**

DR. HENRY E. PAUL, Amphoto, New York, 1960. 124 pp. \$2.50.

By ROBERT E. COX

THOSE AMATEURS fortunate enough to attend the annual meeting of amateur telescope makers at Stellafane near Springfield, Vermont, have always looked forward to discussing their problems and ideas with the many experts and old-timers present. Since the passing of Russell W. Porter and Albert G. Ingalls, the patron fathers of the telescope making hobby in this country, one of the men most in demand as a speaker and source of information at these gatherings has been Dr. Henry E. Paul of Norwich, New York. In the 30 years he has followed the hobby his instrumental and photographic accomplishments have been the envy and inspiration of amateurs throughout the country. Now every amateur can benefit from his experiences through the information assembled in Dr. Paul's new book, *Outer Space Photography for the Amateur*.

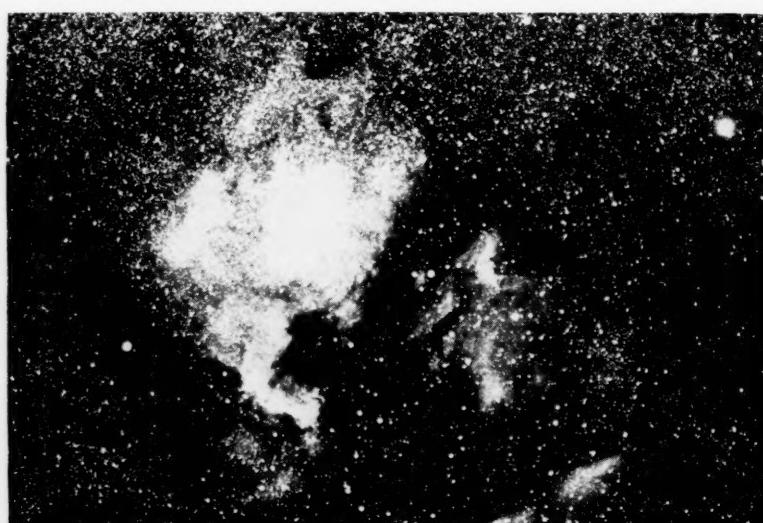
Photography, like so many applied sciences, is a field where the personal preferences and idiosyncrasies of the

individual make acceptance of methods and techniques of others difficult. The author has wisely avoided this pitfall by presenting his material in a general, but valuable and informative, manner. Where necessary certain emulsions and developers are recommended, but as recommended and not absolutely necessary working materials the reader is still privileged to experiment with other items. This does not discourage the beginner who, living in an isolated community not having available a large selection of photographic supplies, must improvise from the limited selection carried in the local store.

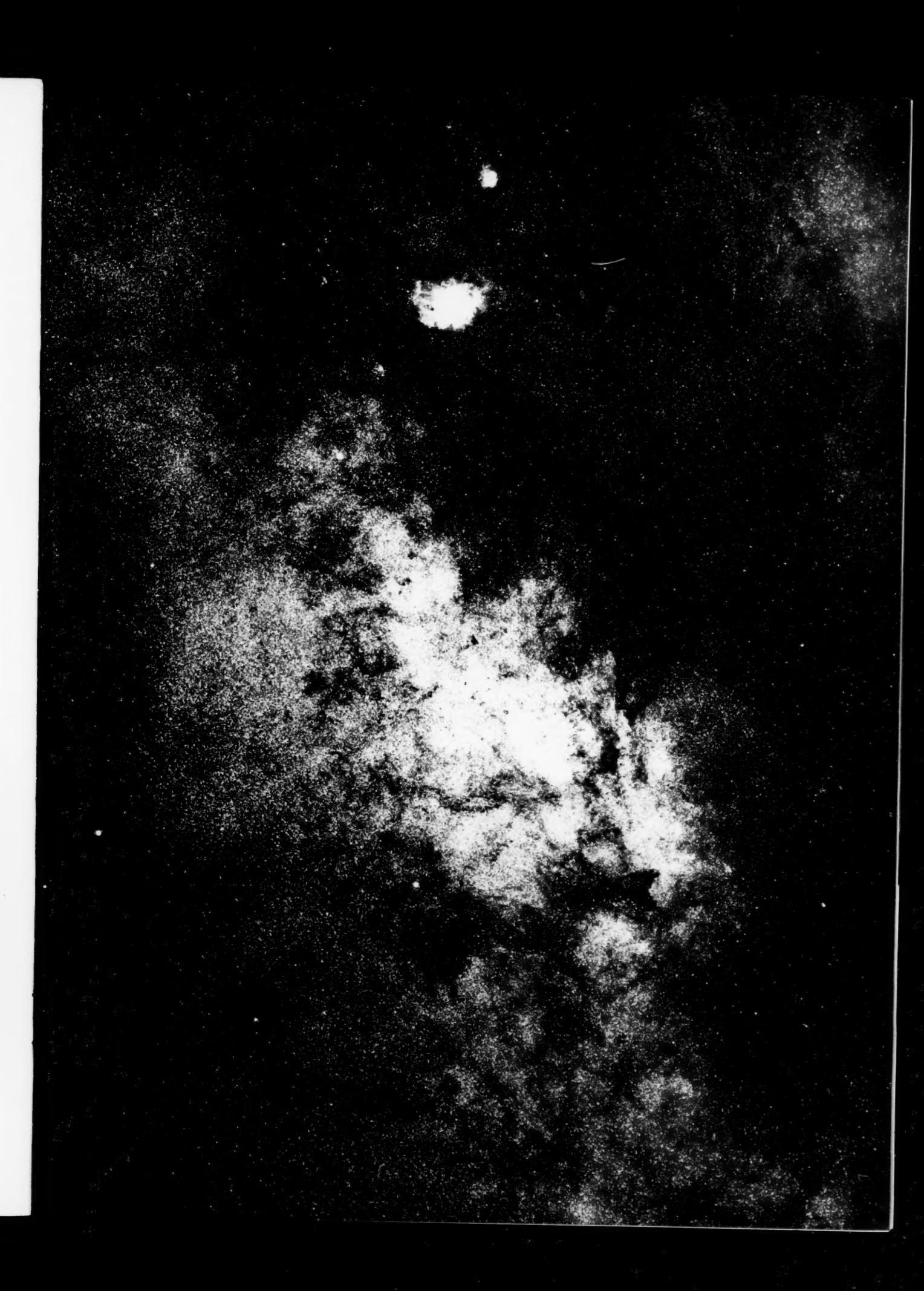
A promising field, and one not considered in as much detail before in similar publication, is that of the application of the Polaroid camera to astronomical photography. The new high-speed Polaroid emulsion (Type 47, ASA 3000) provided many interesting constellation pictures for Dr. Paul's book. The writer has a similar camera and, although he prefers to take astronomical pictures on

(Continued on page 25)

Astrophotographer Alan McClure captures the heart of the Galaxy—the great star cloud in Sagittarius. Lagoon nebula is prominent near top, with Trifid nebula visible above and slightly to right. →



The North America nebula in Cygnus, so named for its obvious resemblance to our continent, is pictured here in a photograph made by Alan McClure of Los Angeles. Exposure was 55 minutes with an f/5 Goto lens of 20-inch focal length. Star at upper right is Deneb. On dark, clear nights this object is faintly visible to good eyes in binoculars or small, short-focus telescopes.



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. . . I have had many years of experience in astronomy, and as junior leader here in Atlanta I always recommend Dynascope. —LEONARD B. ABBEY, Jr., Decatur, Ga.

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(Continued from page 22)

regular negative film in a standard camera, he has successfully used Polaroid Type 42 (ASA 200) film to record an aurora and the passage of Echo I. Dr. Paul's pictures confirm that, by using the fast Polaroid emulsion the amateur astrophotographer should be able to record constellation outlines and reasonably faint objects with short exposures.

By limiting techniques to cameras and telescopes without driving clocks through most of the book, the author makes the material of great value to the "little fellow" with his limited equipment and knowledge of astronomy and photography. The chapters on "Star Trails," "Rockets and Satellites," "The Sun," "The Moon," "Eclipses," "Aurorae" and "Meteors" present enough ideas to keep any amateur busy for an extended period of time and at a minimum of expense. For amateurs intending to attempt extended exposures that require more elaborate equipment, Chapter 3—"Telescopes, Mountings and Drives"—will prove most helpful and at the same time reveal the complexity of equipment needed by such an ambitious person. The material on extended star fields, clusters, nebulae, comets and the planets reveals, however, that the results of this advanced type of celestial probing can be most rewarding.

The book contains 131 photographs, a few being of instruments but most of them illustrating amateur photography at its best. Although from his vast collection of astronomical photographs Dr. Paul could have illustrated many sections of the book himself he has instead secured the work of a number of well-known and experienced amateurs to cover many objects. Among the better known contributors are Horace Dall of Luton, England; Euigenio Silva of Portugal; and American amateurs Dr. Clarence P. Custer, Dr. S. R. B. Cooke, Ralph and Dorothy Davis, Ralph Dakin, Paul W. Davis, Dr. A. Dounce, Walter Semeraru and Alan McClure. (Mr. McClure is well known to readers of this magazine for his many excellent contributions, his picture of the area surrounding Orion's belt and sword being the cover feature of this issue).

The reproductions in the book are well done, and in many instances one thinks he is viewing the products of large observatories rather than amateur efforts. There are a few errors



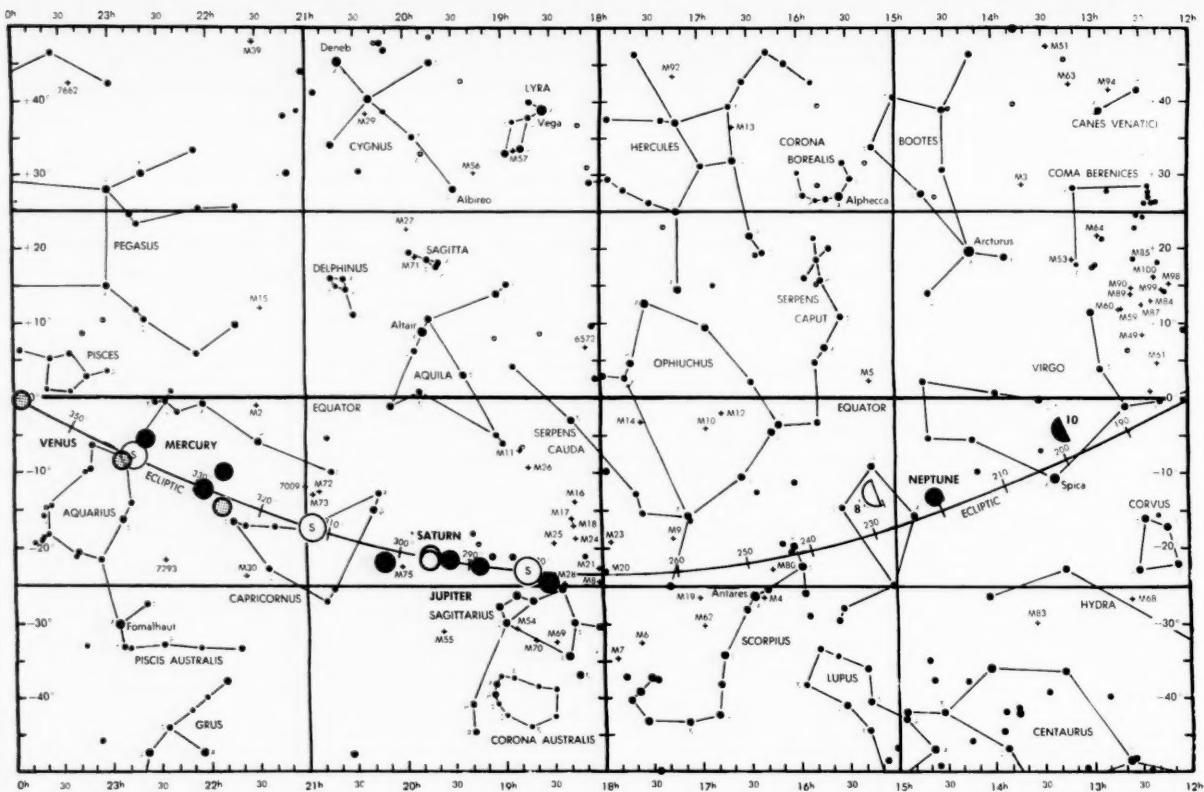
Another McClure photograph, this time of the Andromeda galaxy. McClure used his 7-inch f/7 Fecker triplet lens for this long-exposure photo. Not a subject for the beginner, but an example of what can be done by an amateur willing to experiment, take pains, search for available lenses and equipment. McClure drives several hours at night to a mountain peak to make his photos, spending much of the time wrestling with recalcitrant drives and other bugaboos which plague the astrophotographer.

in the printing—in fig. 7, the 2-inch aperture referred to should be 20-inch; fig. 58 has the upper right moon photo reproduced twice as large as it should be; in fig. 61 the moon should be rotated 90° clockwise for proper viewing; on p. 89, line 5, the 4X should read 3X; and one or two minor typographical errors appear in the text. However, they are not serious and in no way detract from the usefulness and value of the material presented. The writer is sure that these will be corrected at an early printing of this fine little book.

Incidentally, anticipating future printings (and this should prove popular enough to reach this stage quickly) the author invites amateurs to submit their best photographs for

possible future publication. If in doubt as to the caliber of work desired, *Outer Space Photography for the Amateur* will illustrate this point better than words can convey.

A well-known American product has used the slogan "Ask the Man Who Owns One," implying "ask the man with the experience." This book of Dr. Henry Paul enables the beginning amateur to do just that, offering 30 years of experience in a compact package to assist and inspire anyone to attempt celestial photography with assured success. In this reviewer's estimation the book is a required item in the library of every amateur astronomer who wishes an introduction to the photography of the heavens, either for pleasure or for scientific record.



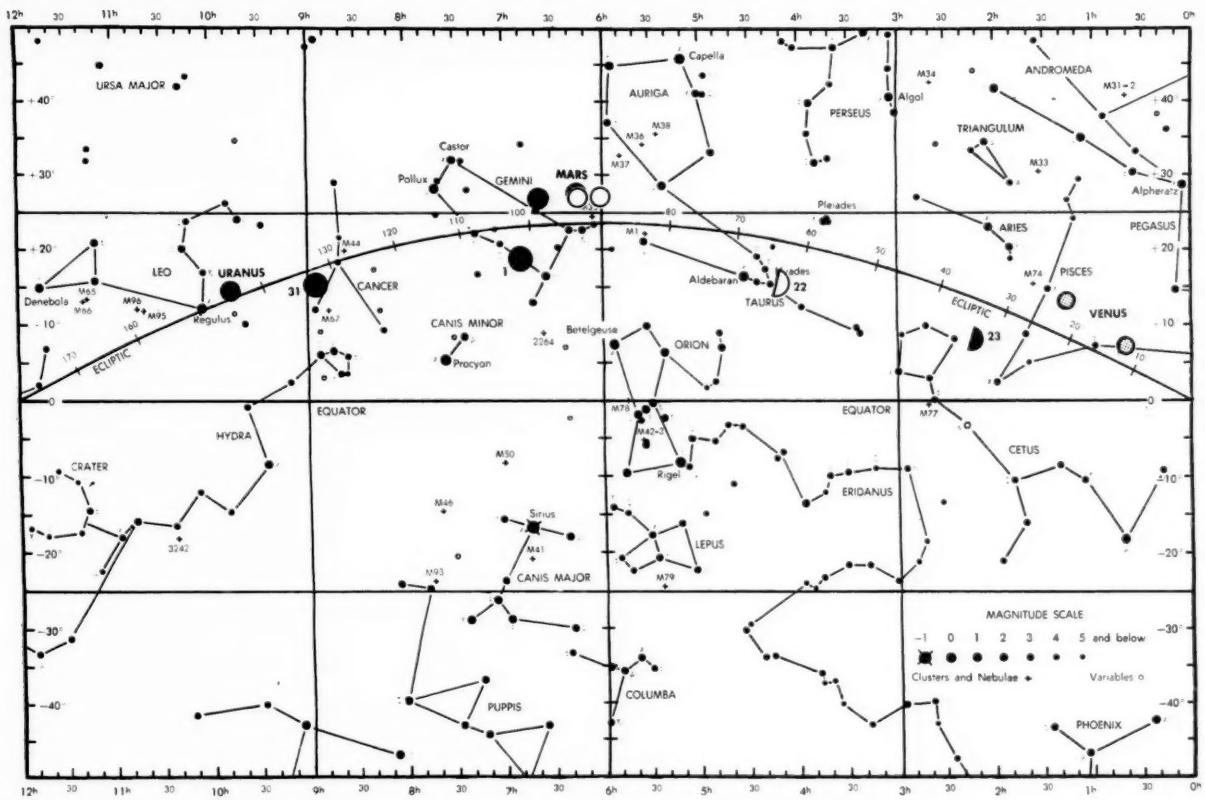
EQUATORIAL SKY MAP

The charts on these pages show the star field from the equator to 50° south and 50° north. Right ascension is measured from west to east in hours; each notch at the top and bottom of the charts represents $10m$ of right ascension. Declination is measured to the north and south of the equator in degrees plus or minus; each notch at the right and left of the chart represents 5° of declination. Longitude along ecliptic is measured in 10° segments.

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Charts indicate position of sun for 1st of each month. Mercury (solid) and Venus (shaded) are shown for the 1st and 15th of each month, and the end of the last month. Mars is plotted for 1st and 15th of each month; Jupiter and other planets for 15th of each month. Position and phase of the moon is also indicated. Positions of moon and planets and November are shown by black circles; for December by outlined circles.

Chart is a natural projection and contains all stars through fifth magnitude (and some fainter). Bright stars are labeled with their proper names. Clusters and nebulae in Messier's catalogue are included, as are all variable stars with maxima brighter than magnitude 8.0. Circumpolar stars may be located on the evening sky map for the appropriate month.

JANUARY AND FEBRUARY AMONG THE PLANETS

SUN: The sun is in Sagittarius at the beginning of January, moving into Capricornus later in the month and finally into Aquarius at the end of February. On Feb. 15th the sun will be eclipsed by the moon. The eclipse, which will be invisible in America, will be partial throughout most of Europe, North Africa and Asia. The path of totality begins in France and passes across southern Europe and Russia into Siberia. This will be the only total eclipse, either of the sun or the moon, to occur during 1961.

MERCURY: Mercury reaches greatest elongation east of the sun on Feb. 6th and will be fairly well placed for observation around that time in the southwestern sky after sunset. It will shine at magnitude -0.5 , but will not offer an easy target in the sunset sky, since it will be just 18° from the sun. Mercury will show a disk slightly more than half illuminated at that time. On Feb. 19th it reaches inferior conjunction.

VENUS: Venus reaches greatest eastern elongation from the sun (47°) on Jan. 26th, dominating the early evening sky as it has for several months. The planet brightens from -3.7 to -4.3 during the two-month period. At the end of January Venus will be half-illuminated, but will

show a pronounced crescent and a disk of $36''$ of arc by the end of February.

MARS: Mars will recede from the earth quickly during January, starting the month with a disk of $15''$ of arc and shrinking to less than $10''$ by the end of February. It will fade from -1.3 at the beginning of the period to 0.2 at the end. Mars rules the night sky during January, bright, ruddy and inviting near the zenith during the pre-midnight hours now that opposition is past.

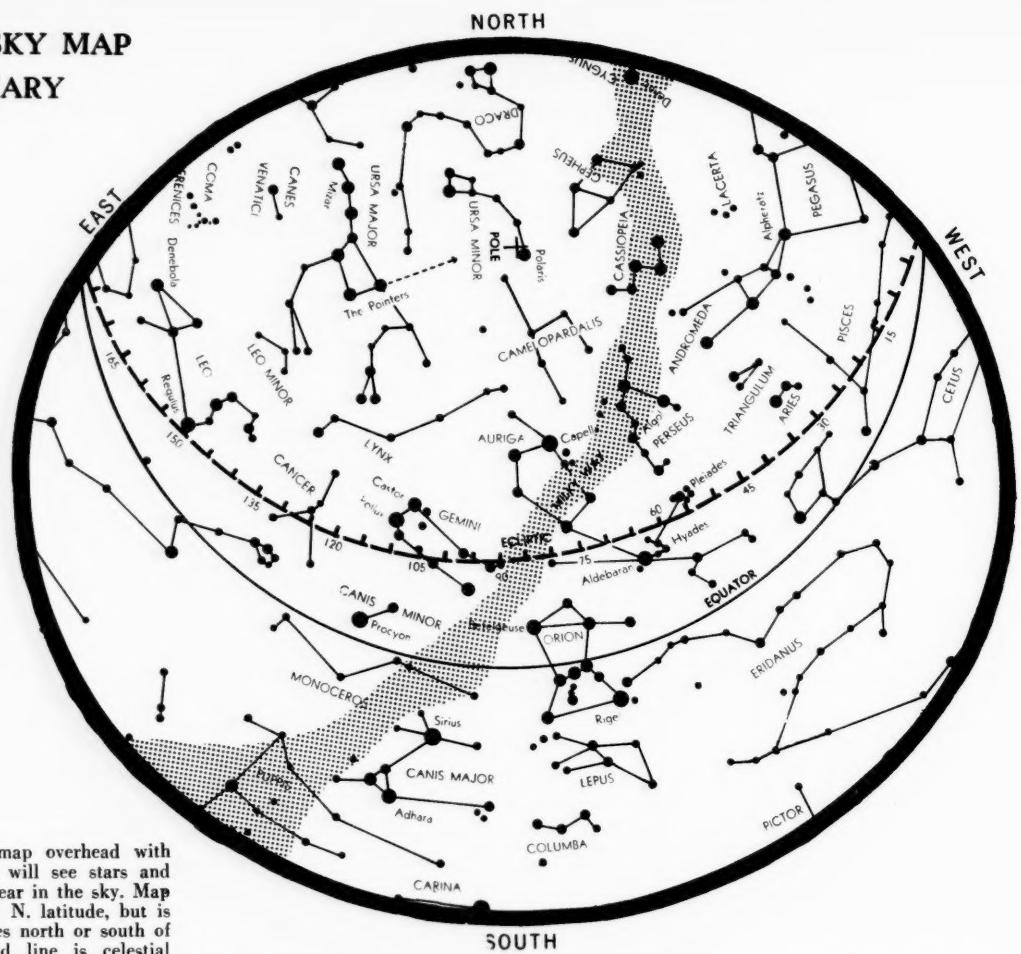
JUPITER: Jupiter moves into conjunction with the sun on Jan. 6th and is of no interest to observers during this period. (No satellite diagrams are shown in this issue.)

SATURN: Saturn joins Jupiter in conjunction with the sun on Jan. 11th.

URANUS: Uranus reaches opposition with the sun on Feb. 12th, a naked-eye object for good eyes and skies at 5.7 in Leo. Its coordinates at time of opposition are RA $9^{\text{h}} 45^{\text{m}}$, Dec $14^\circ 19' \text{N}$, west of Regulus and near the border of Cancer.

NEPTUNE: Neptune is an 8th-magnitude object in Libra at RA $14^{\text{h}} 37^{\text{m}}$, Dec $13^\circ 30' \text{S}$. It reaches opposition this spring.

EVENING SKY MAP FOR FEBRUARY



Face south, hold map overhead with north at top. You will see stars and planets as they appear in the sky. Map is designed for 40° N. latitude, but is practical ten degrees north or south of that latitude. Solid line is celestial equator; dashed line is ecliptic, the apparent path of sun and planets.

9:30 p.m., Feb. 1

8:30 p.m., Feb. 15

7:30 p.m., Feb. 28



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SKY WATCHER'S DIARY

JANUARY

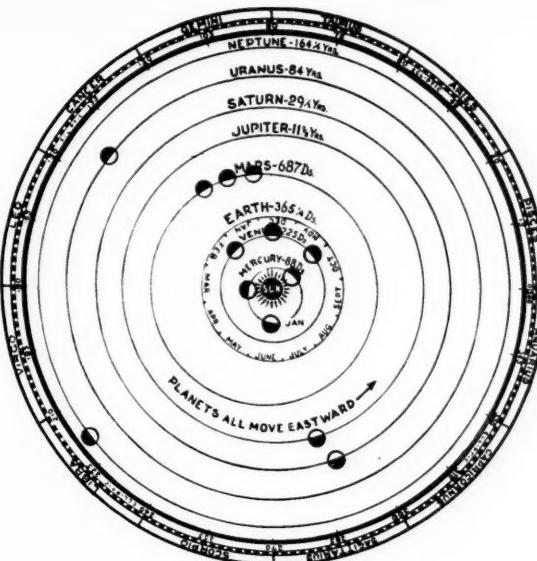
Date (EST)	Event
1 12	Mars 8° N. of moon
1 18	Full moon
2 00	Earth at perihelion
3 08	Moon at apogee
5 13	Uranus 2° N. of moon
5 13	Jupiter in conjunction with sun
5 18	Mercury in superior conjunction
9 22	Last quarter
11 01	Saturn in conjunction with sun
11 11	Neptune 3° S. of moon
16 16	New moon
16 18	Moon at perigee
20 00	Venus 0°.6 N. of moon
23 11	First quarter
26 08	Aldebaran 0°.3 S. of moon
28 02	Mars 8° N. of moon
29 02	Venus greatest elong. E. (47°)
30 08	Moon at apogee
31 14	Full moon

FEBRUARY

Date (EST)	Event
1 16	Uranus 2° N. of moon
2 02	Regulus 1° N. of moon
5 22	Mars stationary
6 07	Mercury greatest elong. E. (18°)
7 19	Neptune 3° S. of moon
8 12	Last quarter
11 20	Neptune stationary
12 04	Mercury stationary
12 12	Uranus at opposition
13 01	Jupiter 4° S. of moon
13 02	Saturn 3° S. of moon
14 06	Moon at perigee
15 03	New moon
18 06	Venus 7° N. of moon
18 10	Jupiter 0°.2 S. of Saturn
21 19	Mercury in inferior conjunction
22 04	First quarter
22 15	Aldebaran 0°.2 S. of moon
24 12	Mars 8° N. of moon
25 12	Pluto at opposition
26 16	Moon at apogee

The phenomena of Jupiter's satellites have been omitted in this issue because of the planet's proximity to the sun. They will be resumed in the next issue. A new feature will be charts and data on the brighter asteroids, written by Walter Scott Houston. Dr. Paul Herget, director of the International Astronomical Union's Minor Planet Center at the Cincinnati Observatory, has informed us that the ephemerides for 1961 are being published in the Soviet Union and have not yet been received at the Center.

Mr. Houston, a contributing editor to this magazine, is presently editor of the physics section of the new *SCIENCE AND MATH WEEKLY*, a publication for high-school students published in Middletown, Conn.



HELIOCENTRIC
POSITIONS
of the
PLANETS
for
JANUARY
and
FEBRUARY
1961

This chart shows the solar system as it would appear if viewed from a point directly above the sun (in relation to the plane of the ecliptic). Heliocentric positions of the planets are measured in degrees of longitude, eastward from the First Point of Aries. Owing to space limitations, the orbits of the planets are not to scale. Positions at beginning, middle and end of two-month period are shown for Mercury, Venus, Earth and Mars—mean position during period is shown for each of the outer planets.

SOLAR, SIDEREAL AND UNIVERSAL TIME

Any recurring event may be used to measure time. The various times commonly used are defined by the daily passages or the stars caused by the rotation of the earth on its axis. The more uniform revolution of the earth about the sun, causing the return of the seasons, defines ephemeris time.

A sun-dial indicates *apparent solar time*, but this is far from uniform because of the earth's elliptical orbit and the inclination of the ecliptic. If the real sun is replaced by a fictitious mean sun moving uniformly in the equator, we have *mean (solar) time*. *Apparent time - mean time = equation of time*.

If instead of the sun we use stars, we have *sidereal time*. The sidereal time is zero when the vernal equinox or first of Aires is on the meridian. As the earth makes one more revolution with respect to the stars than it does with respect to the sun, sidereal time gains on mean time $3^{\text{m}}56^{\text{s}}$ per day or 2 hours per month. Right Ascension (R.A.) is measured east from the vernal equinox, so that the R.A. of a body on the meridian is equal to the sidereal time.

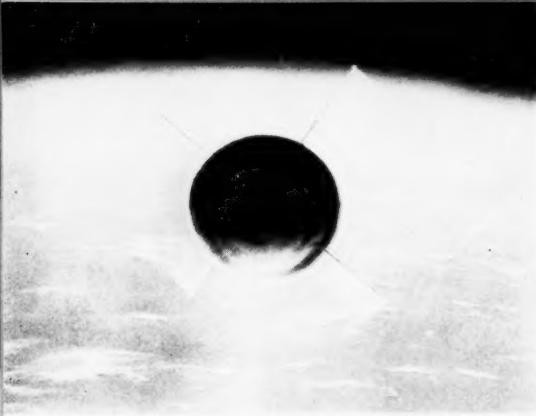
Sidereal time is equal to mean time plus the R.A. of the fictitious mean sun, so that by observation of one kind of time we can calculate the other. Sidereal time = Standard time (0h at midnight) - correction for longitude + 12 h + R.A. sun - correction to sun-dial. (Note that it is necessary to obtain R.A. of the sun at the standard time involved.)

The foregoing refers to *local time*, in general different in different places on the earth. The local mean time of Greenwich, now known as *Universal Time (UT)* is used as a common basis for timekeeping. Navigation and surveying tables are generally prepared in terms of UT.

To avoid the inconveniences to travellers of a changing, local time, *standard time* is used. The earth is divided into 24 zones, each ideally 15 degrees wide, the zero zone being centered on the Greenwich meridian. All clocks within the same zone will read the same time.

In Canada and the United States there are 8 standard time zones as follows: Newfoundland (N), 3 $\frac{1}{2}$ hours slower than Greenwich; 60th meridian or Atlantic (A), 4 hours; 75th meridian or Eastern (E), 5 hours; 90th meridian or Central (C), 6 hours; 105th meridian or Mountain (M), 7 hours; 120th meridian or Pacific (P), 8 hours; 135th meridian or Yukon (Y), 9 hours; and 150th meridian or Alaska (AL), 10 hours slower than Greenwich.

(Reprinted from 1961 HANDBOOK of the Royal Astronomical Society of Canada.)



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IN THE MOONWATCH ORBIT . . .

The human eye, especially at the telescope, continues to provide significant useful data, even though nowadays rather sophisticated electronic and other sensing equipment is being developed to detect and track artificial earth satellites.

The trained eye of the Moonwatch observer is not infrequently relied upon to a considerable degree for data which can be used either to confirm or to negate other data obtained from observing systems other than optical ones.

Not long ago an attempt was made to separate the capsule of Sputnik IV (1960 Epsilon 1) and at the same time to bring down from orbit the chamber designed to carry a human. An electronic observing system detected that the Russians had somehow produced not one new object as intended, but four. Would Moon-

watch please investigate—were there, in fact, four new objects? Within a few hours Moonwatch teams confirmed the multiplication; indeed, had observed that not four but six new objects were in orbit. Moreover, measurements were made of their positions. A sidelight is that the Rochester, New York, Moonwatch station of Russell Jenkins, independently and prior to the request for conformation, had already made observations of four new components of the sputnik. Mr. Jenkins further reported that the Rochester observers had somewhat less than positive evidence that a number of additional components also could be presumed to be in orbit.

There was the case of Echo I (1960 Iota 1) launched on August 12. During the first two weeks it remained constantly in daylight. When it was about to commence dipping into the earth's shadow for intervals of a few minutes, Moonwatch was called upon to carry out a special assignment, the results of which were expected to answer the following question: In the event that gas remained in the balloon, what would be the effects on the balloon's shape of the reduced internal pressure (gas solidifying) due to a sharp drop in temperature as the balloon penetrated the shadow? Measurements of the magnitudes of the satellite as it passed into the penumbra and umbra, and then out, would provide an answer. Such data were soon obtained by a number of Moonwatch teams, and the evidence was conclusive that

no changes occurred before, during or after the dipping into the shadow.

Moonwatch stations in mid-1959 performed still another special assignment; in fact, it turned out to be a double assignment. The observers re-acquired Explorer IV (1958 Epsilon) not once, but twice. The need for the effort arose when the satellite suddenly was found not to be in its predicted position; indeed, it couldn't be found. Thus, the Smithsonian Observatory's Baker-Nunn cameras were unable to photograph this extremely faint object. It had become lost during a short interval in which routine observations were unobtainable, chiefly because of unfavorable weather and visibility-zone conditions. The task of Moonwatch was to search along the orbit plane. Within a few days the object was re-acquired. Soon it became lost again, and was then re-found. Thereafter, however, it was tracked virtually up to the time of its decay on October 23, 1959. It is pertinent to note that the technique used in these searches along the orbit path was developed and refined by Arthur S. Leonard, Sacramento, California, Moonwatch team leader who, with his observers, contributed outstandingly to the achievement.

My last example of the unique capabilities of Moonwatch observers concerns the single-handed search that led to the discovery of the last-stage rocket case that carried Vanguard 1 (1958 Beta 2) into space. The rocket, 1958 Beta 1, was as faint as 9th magnitude, and remained undetected by any means for several



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months. Not until a rather large number of visual observing teams made a concentrated search did the satellite come under surveillance. Again, it is to be noted Mr. Leonard and his Sacramento observers were greatly instrumental in making this acquisition.

There is on record additional evidence of Moonwatch observers' particular capabilities as measured by actual results. But it is too extensive to be cited here.

To summarize, the trained eye at the telescope appears to be without equal for pursuing important, essential phases in observing artificial earth satellites. The ancient adage, "seeing is believing" remains profoundly true.

THE TELESCOPE MART

Classified advertising costs just 15c per word (minimum of 10 words). Count all cities or states as one word; include but do not count postal zone numbers. Cost of ad must accompany order. Deadline is 25th of second month preceding next issue (Jan.-Feb. issue, Nov. 25th). Please print or type copy. Sky Map Publications cannot assume responsibility for items advertised in or purchased through this section. Address Classified Advertising, Review of Popular Astronomy, Box 231, St. Louis 5, Mo.

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The author's own observatory, housing his 12-inch reflector. Both attractive and utilitarian, the home follows the Romsey pattern described in greater detail in the accompanying article. Notice flap at top of dome which may be raised to afford view of zenith.

YOUR TELESCOPE AND MINE

AMATEUR OBSERVATORIES

BY THOMAS R. CAVE

ONCE THE AMATEUR astronomer has acquired a good telescope of reasonable size and has begun regular observing, he begins to appreciate his instrument's capabilities. Soon he finds that the time spent in erecting and dismantling his telescope each night is a bit discouraging to frequent sessions at the eyepiece. The warm, balmy nights of summer may be most pleasant for observing in the open air; yet, much of the year the breezy, colder nights make open-air telescopic work far less pleasant. Most telescopists, undoubtedly, sooner or later seriously consider some type of homemade shelter or observatory for their instrument which will afford weather-tight protection for the telescope and some protection for themselves. The ideal of many amateurs is a beautiful hemispherical dome neatly appointed in every detail, but cost or difficulty of construction soon causes many amateurs to modify their planned observatory to a more economical and modest building.

Basically, there are at least five distinct types of amateur observatories in use today:

The first type should not, perhaps, be termed an observatory. The late William Tyler Olcott and others

many years ago recommended a folding two- or three-wall shelter constructed of light-weight framed material and hinged to offer the owner of a small refractor a movable windbreak for his telescope. Such a simple shelter can be built very cheaply by using $\frac{1}{8}$ -inch Masonite in standard 4x8-foot sections, each section surrounded by a light frame. Each section can be joined together by door hinges along the 4-foot sides. From two to four of these standard sections can be hinged together to form either a simple windbreak for the telescope or an enclosed area of ground about eight feet square. When not in use, these sections can be folded together for easy storage. At the present prices of materials, such a simple four-side portable observatory can be constructed for about \$25-\$30 total cost.

The second type of observatory is simply a roll-off building, which allows the telescope to be permanently mounted and fully protected from the weather when not in use. Usually one end of the building consists of a door which can be opened and the entire building rolled on wheels several feet to the north of the telescope. Frequently, some form of track or rails embedded in the



This double slide-off-roof housing is located at the Oak Ridge station of the Harvard College Observatory in Massachusetts, but illustrates the basic simplicity of this design as a consideration for the amateur. Both or either of the room components slide off on supporting struts, affording a less obstructed view of the heavens.

ground allows the telescope housing to be rolled away from the instrument quite easily. If well constructed, this type of shelter affords excellent protection for the telescope; however, it offers no shelter at all for the observer. In tropical climates such a removable shelter has definite advantages and was used for many years at Mandeville, Jamaica, by Prof. W. H. Pickering to cover an 11-inch refracting telescope. Instruments of rather large size can be well protected from bad weather by using this type of shelter, yet at the lowest possible cost.

Certainly, the most popular amateur observatory in America is the third basic type—the slide-off roof.

This form of amateur telescope housing first became popular in the 1920's when many observers housed their fine 5-inch and 6-inch refractors in this manner. This type of building is ideally suited for refracting telescopes, since the observer is always protected below the roof line of the building during all observations. Normally the building is constructed in the same manner as any small square building of ten- or 12-foot size. The telescope is mounted independently of the floor on a concrete pier. The entire roof may either be rolled off to the north on well braced overhead rails, or the roof can be divided into two half-sections, each section rolling off

(usually east and west). Many observers prefer the two-section roof, since one section can be left on the building while observations are made in the other half of the sky; this allows greater protection to the observer. Although this plan of observatory has proved almost ideal for refractors, it has also often been used with newtonian reflectors by building the walls lower so the reflector has good access near the horizon. It is interesting to note that several large professional observatories, both in the United States and abroad, have recently adopted this type of instrument building with great success and at only a fraction of the cost of the more elaborate dome type of building.

One of the few amateurs to gain recognition as an observer and as an optical expert, Tom Cave is in an unusual position to advise the amateur of problems relating to mirror-making, mountings and the use of telescopes. Beginning with the next issue, Mr. Cave's feature will include answers to questions and requests for comment sent in by readers. If you have a question, a problem, or a new idea, send Mr. Cave a letter. Photos intended for reproduction should be at least 4x5 and on glossy paper. Address your communication to:

T. R. Cave
Sky Map Publications, Inc.
Box 231, St. Louis 5, Mo.

While the first three general types of observatory buildings have long been popular, many observers desire to build a more "astronomical" appearing observatory that incorporates some form of rotating dome. Far simpler than the true hemispherical dome is the more straight-line type. About the middle of the nineteenth century an English clergyman, the Rev. Berthon, devised an off-angle cone-type dome with hinged shutters, reasonably simple to construct and well suited for a 6-inch refractor or 10- to 12-inch reflector. The construction became known as the Romsey dome and for many years was popular in England. A number of modified Romsey domes have been constructed in America. Perhaps a more pleasing straight-line dome—and as easily built—is the truncated cone form, or "Mars Hill" dome. The same type of hinged shutters is used on this dome, except that the zenith

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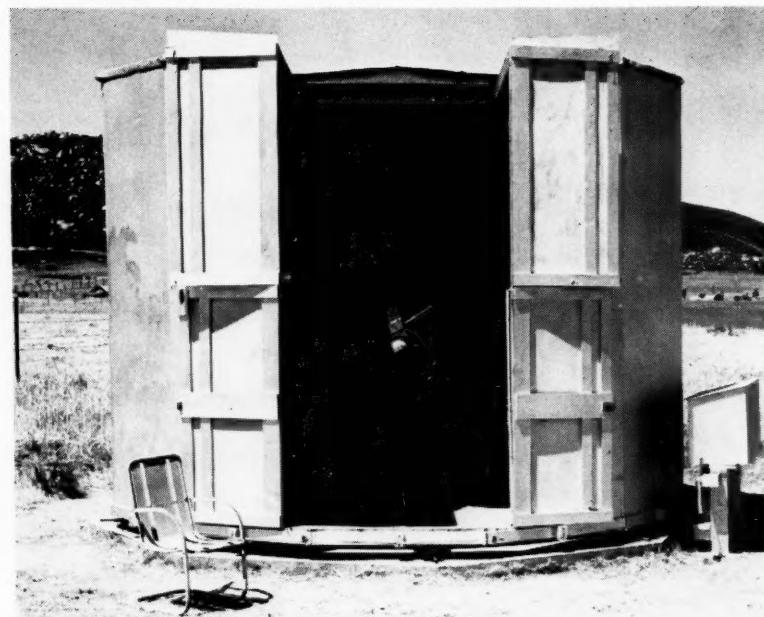
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hatch or shutter may either be hinged and pulled up by strong springs or rolled back to allow overhead viewing.

Possibly the best plan in the design of a small domed observatory is to construct a square, low basic building with walls from 5 feet to 6½ feet in height and topped with the circular dome. The corners of the building allow for a small desk, book shelves, extra chairs, etc. The track may be made of heavy strap-iron accurately curved in sections of a circle and welded together. Great care should be made to attach the track to the building in order to keep it accurately round and level. Small iron pulley wheels fastened to steel brackets will allow the dome to be rotated very easily by hand if the dome does not exceed about 12 feet in diameter. Larger size domes usually require an electric motor to rotate the dome.

The fifth form of observatory is the classic hemispherical dome with one or two curved shutters. Such a dome will easily cost from three to five times as much to construct, and



This unusual but practical observatory is "all dome." Designed by California amateur Claude Carpenter for his 18-inch reflector, the entire building rotates on a track. A long-time variable star observer, Carpenter has found this arrangement to be efficient and simple to operate. Photograph courtesy of the author.

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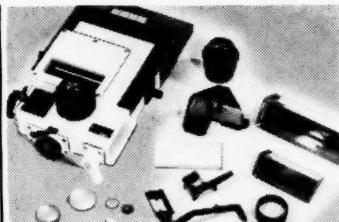
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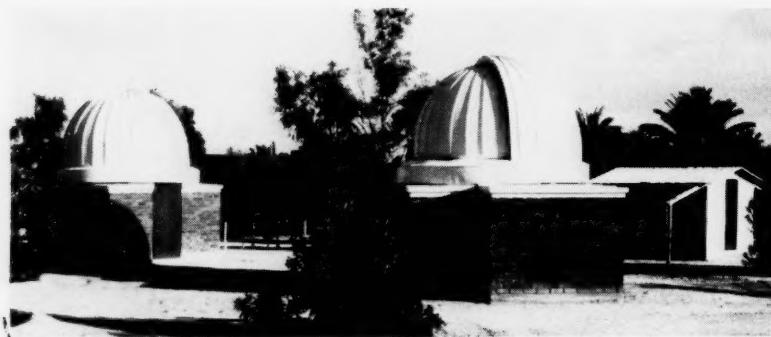
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The student observatory of the University of Arizona in Tucson, showing the two "dome within a dome" buildings behind the Steward Observatory. Domes consist of two semi-hemispheres, one rotating within the other and giving an unobstructed view of half the sky when opened.

several times as much labor will be required than in building a straight-line type of dome. For the particularly skillful amateur with adequate tools this form of observatory offers a challenge and is certainly the most beautiful and striking of all observatory buildings when well made.

Excellent custom and prefabricated domes are now available commercially, and attempts are being made to bring the prices within the range of the average telescope user. From a purely practical standpoint, however, the straight line dome offers all the advantages of the hemisphere with as much or more headroom when using a newtonian reflector, the same protection from wind and outside light, and can be made nearly as attractive if the straight-line dome is carefully planned and constructed.

Most amateurs always build their observatories too small. It is almost as economical to build the observatory a few feet larger and often requires little more labor. The observatory constructed for your present telescope may be large enough, yet later a larger telescope may not fit the observatory. It is well to plan your building for a larger telescope than you first plan to house. Once the amateur has his telescope in a permanent observatory building, he will find more pleasure in observing and more time well spent at the telescope than ever before.

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For such as these, there is a fourth Law of Astromoney:

"If you would enjoy your UNITRON, and Keep the Wolf at bay—
Send just one tenth its Price—and take a Year to pay."

The wisdom contained in the fourth Law is summarized in the adjacent Table. It is as Valuable for the Reader as the Rudolphine Tables were for the contemporaries of Kepler.

Pursuing pleasure in the picture above are a few of the many interesting visitors who participate in the "Star Gazers" meetings offered by the Long Island State Park Commission in association with Abraham and Straus. Mr. Percy Proctor, director, indicates the location of a planet while a youngster views it through a UNITRON 2.4" Altazimuth Refractor.

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3" Alt.	265	26.50	21.05
3" Eq.	435	43.50	34.59
3" Ph. Eq.	550	55.00	43.72
4" Alt.	465	46.50	36.96
4" Eq.	785	78.50	62.40
4" 160	1175	117.50	91.41
4" 166	1280	128.00	101.76

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